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EmoJar: Collecting and Reliving Memorable and Emotionally Impactful Digital Content

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Abstract

Nowadays, the consumption of digital content occupies a significant part of our days. Indeed, accessing and promptly consuming a wide variety of digital content – ranging from video and audio, to images and text – has never been easier, with the proliferation of new technological solutions (among which smartphones and tablets naturally stand out), the availability of countless applications and platforms for accessing digital content, and the democratisation of the Internet all having contributed to this. In addition to promoting and supporting cognition, learning, and creative thinking, contributing to our productivity, and playing a very significant role in what our daily entertainment is concerned, digital content is highly capable of evoking a wide range of emotions, of regulating and improving our mood, of helping us become more aware of our emotions, and of fostering positive attitudes, all of which positively contribute to our psychological wellbeing and quality of life.

Although digital content has all this potential – that of being emotionally impactful and capable of promoting and supporting the psychological wellbeing of those who consume it – few applications and platforms are dedicated to exploring it, with even fewer offering its users the means and mechanisms by which they may describe and later understand what has made a given digital content memorable, emotionally impactful, and capable of promoting one's psychological wellbeing. In that sense, this work will address the consumption of digital content, the experience of emotions, and the ways in which both relate and contribute to the psychological wellbeing of individuals, and then propose and describe the emoJar system, which was designed based on the Happiness Jar concept (where we have a jar in which we place small pieces of paper describing things that made us feel happy, proud, or grateful, to be later recalled), and developed as an extension to the Media4WellBeing application that allows its users to not only collect and later reexperience digital content that they have considered memorable and that has positively contributed to their psychological wellbeing, but also makes it possible for them to describe, recall, relive, and above all understand what emotions (recognized through the optional use of physiological sensors, and/or through self-report) were experienced throughout said digital content's consumption and why.

Throughout this document, we will present a set of studies, concepts, applications, and platforms that have somehow inspired the design and development of the emoJar system, whose user evaluation results were very encouraging (with the proposed solution having been praised for its usability, usefulness, satisfaction, and ease of use, and seen as appealing and possessing certain ergonomic and hedonic qualities) and gave us a clear idea of the aspects that should be improved and explored.

In the future, we expect to evolve this work's concepts and mechanisms even further, always with the ultimate goal of contributing to individuals' development and psychological wellbeing (a goal that is aligned with those of Positive Psychology and Positive Computing, two scientific fields that informed the development of this work).

Keywords: Digital Content, Wellbeing, Emotions, Happiness Jar, Self-assessment

Resumo

Atualmente, o consumo de conteúdos digitais ocupa uma parte significativa dos nossos dias. De facto, aceder e prontamente consumir uma grande variedade de conteúdos digitais – desde vídeo (do mais pequeno clipe, ao mais longo e elaborado filme) e áudio (desde podcasts, a audiolivros e música), a imagens (como "memes", GIF's animados, e fotografias de situações, pessoas, e paisagens deslumbrantes) e texto (factual ou literário) – nunca foi tão fácil, tendo para tal contribuído a proliferação de novas soluções tecnológicas (entre as quais naturalmente se destacam os smartphones e tablets), a disponibilização de inúmeras aplicações e plataformas de acesso a conteúdos digitais (como o YouTube e o Spotify, no caso do vídeo e áudio, respectivamente), e a democratização da Internet. Para além de reconhecidamente promoverem e suportarem a cognição, aprendizagem, e pensamento criativo, de contribuírem para a nossa produtividade, e de terem um papel muito significativo no que ao nosso entretenimento diário respeita, os conteúdos digitais são altamente capazes de despertar em nós uma panóplia de emoções, de regular e melhorar o nosso humor, de nos tornar mais conscientes das nossas emoções, e de fomentar atitudes positivas, aspectos que contribuem positivamente para o nosso bem-estar psicológico e qualidade de vida.

Apesar dos conteúdos digitais terem todo este potencial – o de serem emocionalmente impactantes e capazes de promover e dar suporte ao bem-estar psicológico de quem os consome – poucas são as aplicações e plataformas que se dedicam a explorá-lo, e ainda menos são aquelas que oferecem aos seus utilizadores os meios e mecanismos necessários para descrever e mais tarde entender o que tornou um determinado conteúdo digital memorável, emocionalmente impactante, e promotor do seu bem-estar psicológico. Nesse sentido, neste trabalho abordaremos o consumo de conteúdos digitais, a experiência de emoções, e a forma como ambos se relacionam e contribuem para o bem-estar psicológico de um indivíduo, para de seguida propor e descrever o sistema emoJar, que foi projectado tendo como base o conceito da Happiness Jar (em que temos uma jarra na qual depositamos pequenos papelinhos que essencialmente descrevem coisas que nos fizeram sentir felizes, orgulhosos, ou gratos, para mais tarde recordar), e desenvolvido como uma extensão à aplicação Media4WellBeing para permitir que os seus utilizadores, para além de colecionarem para mais tarde voltarem a experienciar conteúdos digitais que tenham considerado

memoráveis e que tenham positivamente contribuído para o seu bem-estar psicológico, possam também descrever e mais tarde recordar, reviver, e sobretudo entender que emoções (reconhecidas através do uso opcional de sensores fisiológicos, e/ou por via do autorrelato) foram experienciadas aquando do seu consumo e porquê.

De uma forma muito concreta e sucinta, no primeiro capítulo do presente documento, começaremos por apresentar: 1) o que motivou o desenvolvimento deste trabalho e da solução proposta; 2) que objectivos é que nos propusemos a atingir com a solução concebida; 3) em que contextos é que este trabalho e a solução proposta se inserem; 4) qual é o nosso contributo para o estado da arte; 5) que planeamento é que seguimos para desenvolver este trabalho e a solução proposta; e 6) de que forma é que este trabalho se encontra organizado.

No segundo capítulo, passaremos em revista um conjunto de estudos e conceitos relacionados com o tema deste trabalho, tratando para o efeito tópicos como: 1) o bem-estar, as suas dimensões (objectiva e subjectiva), as áreas científicas que directa ou indirectamente dele se ocupam (como a Psicologia Positiva, a Computação Positiva, e a Computação Afectiva), o que é e em que consiste a Happiness Jar, e que impacto é que esta e os conteúdos digitais podem ter no bem-estar; 2) a história, definições, e especificidades das emoções; 3) os modelos emocionais existentes e mais relevantes, devidamente categorizados e ilustrados; 4) as associações que se fazem entre cores e emoções; 5) as diferentes formas que temos de experienciar, expressar, e reconhecer emoções; e 6) o que são, e que uso pode ser feito de sensores fisiológicos e, em seu complemento ou alternativa, de sensores de dispositivos móveis (i.e., smartphones e tablets).

No terceiro capítulo, faremos um levantamento das ferramentas, aplicações, plataformas, e trabalhos que já existem e estão relacionados com o nosso (não só a fim de destacar as várias contribuições feitas pelos investigadores que nos antecederam, como também para colocar as nossas próprias contribuições no contexto adequado), desta feita cobrindo: 1) as plataformas que dão acesso a uma imensa e variada quantidade de conteúdos digitais, devidamente categorizadas por vídeo (Netflix, TED.com, Vimeo, e YouTube), áudio (Spotify, sendo feita alusão a plataformas similares), e imagem (Flickr e Pinterest); 2) aplicações que exploram a dimensão emocional dos conteúdos digitais (iFelt, MovieClouds, As Music Goes By, e

Media4WellBeing); e 3) e as aplicações que se relacionam com o projecto da Happiness Jar (The Gratitude Jar, The Happiness Jar, HappiJar, e Cove).

No quarto capítulo, faremos uma apresentação de alto nível (i.e., daquilo que é imediatamente visível) do sistema emoJar, começando por descrever os requisitos funcionais e não-funcionais definidos, passando de seguida pela descrição do processo de desenho da interface, e concluindo com a apresentação de cada página e elemento que compõe este sistema.

No quinto capítulo, mergulhamos nas águas profundas do desenvolvimento e implementação do sistema emoJar e das suas funcionalidades, começando por discutir as ferramentas e tecnologias utilizadas, seguindo para a sua arquitectura e modelo de dados, e finalmente discutindo a implementação das funcionalidades mais relevantes de cada página apresentada no capítulo anterior. Ao longo de todo este capítulo (e no decorrer do próximo também), descrevem-se os vários desafios com que nos deparámos, as decisões que se tiveram de tomar em função desses desafios, e reconhecem-se pelo caminho algumas das limitações do sistema, decorrentes da falta de familiaridade com certas tecnologias, da falta de tempo, e de outros constrangimentos que se impuseram e que não tivemos como antecipar ou sequer controlar. No final deste capítulo, apresentam-se algumas métricas relacionadas com a implementação deste sistema (nomeadamente, a quantidade de linhas de código que foram escritas em cada ficheiro que o compõe), bem como o esforço que foi feito para que, de futuro, seja fácil manter, melhorar, e sobretudo perceber o que cada componente do sistema faz e como funciona.

No sexto e penúltimo capítulo, esclarecemos os objectivos da avaliação que foi feita com utilizadores. Descrevemos também todos os passos que se seguiram e tarefas que se realizaram (um total de 10, descritas no presente documento e também num guião que se encontra anexado no final do mesmo) para que, junto destes mesmos utilizadores, nos fosse possível aferir a usabilidade, utilidade, satisfação, e facilidade de uso percebida de cada página e componente do sistema emoJar. Quanto aos resultados da avaliação (bastante encorajadores, tendo a solução proposta sido enaltecida pelo seu conceito, e vista como apelativa e detentora de certas qualidades ergonómicas e hedónicas), esses são apresentados primeiro por extenso e ao detalhe na sua respectiva secção, e mais tarde resumidos ao essencial em duas tabelas.

No sétimo e último capítulo, apresentamos a conclusão deste trabalho, e que desenvolvimentos futuros temos planeados para a solução proposta. Estes desenvolvimentos futuros passam, no fundo, por corrigir e melhorar algumas das principais lacunas do nosso sistema, e por levar os conceitos e mecanismos que nele foram explorados mais além, sempre com o objectivo último de contribuir para o desenvolvimento e bem-estar psicológico dos seus utilizadores (objectivo esse que se alinha com os da Psicologia Positiva e da Computação Positiva, duas áreas científicas que informaram o desenvolvimento deste trabalho).

Palavras-chave: Conteúdos Digitais, Bem-estar, Emoções, Happiness Jar, Autorrelato

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Chapter 1

Introduction

This chapter unveils the subject of this work by elaborating on its motivation, objectives, and context. Furthermore, it defines this work's contributions, development plan, and structure.

1.1 Motivation

In recent decades, we have witnessed the emergence and growth of the Internet, and we have seen how computer devices – such as desktops, laptops, smartphones, and tablets – became common household goods with which individuals can quickly access and readily consume vast amounts of digital content.

Indeed, watching videos (from short clips to feature films), listening to audio content (like podcasts, audiobooks, or music), inspecting images (from memes to animated GIF's and stunning landscape photographs), and reading text (factual or literary) are among the most accessible and appreciated recreational activities that individuals currently indulge in, and it is easy to understand why: aside from entertaining us daily, diverting our attention from our demanding lives, improving cognition (Cockerton et al., 1997; Gold et al., 2013; url-PsychologyMusic), promoting learning (by exposing us to countless bits of information on a given subject), endorsing creative thinking (Ritter & Ferguson, 2017), and aiding in productivity (url-PsychologyMusic), digital content is highly capable of evoking a wide range of emotions, of regulating and improving our mood, of helping us become more aware of our emotions, and of fostering positive attitudes, all of which positively contribute to our psychological wellbeing and quality of life.

Although digital content has all this potential – that of being emotionally impactful and capable of promoting and supporting the psychological wellbeing of

those who consume it – few applications and platforms are dedicated to exploring it, with most related work not allowing users to 1) collect so as to later reexperience digital content with the above-mentioned qualities, and 2) describe and later understand the impact that a given content had on them, what emotions were experienced at the time of its consumption and why, and in what ways said digital content contributed to their psychological wellbeing. It is with that in mind that, after addressing how the consumption of digital content and the experience of emotions relate and contribute to the psychological wellbeing of individuals, we will propose the emoJar system as one that – aligned with the principles and objectives of Positive Psychology, Positive Computing, and Affective Computing (scientific fields that we introduce in the following chapter) – might potentially fill in the gap that we have identified in the related work's landscape.

1.2 Objectives

The objective of this work was to extend the Media4WellBeing application (introduced and thoroughly described in this document's section 3.2.4) by developing interactive mechanisms and perspectives that would allow individuals to 1) collect and reexperience digital content that they have considered memorable and that have positively contributed to their psychological wellbeing, and 2) describe, recall, relive, and above all understand what emotions (recognized through the optional use of physiological sensors, and/or through self-report) were experienced throughout said digital content's consumption and why.

1.3 Context

This work was developed within the scope of my dissertation for the Master's Degree in Informatics at Faculdade de Ciências da Universidade de Lisboa (FCUL), but also in the context of the AWESOME (Awareness While Experiencing and Surfing On Movies through Emotions) project and the Media4WellBeing application, developed at LASIGE.

It is related to previous work such as iFelt (Oliveira et al., 2013), MovieClouds (Martins et al., 2011), As Music Goes By (Moreira & Chambel, 2018), and Media4WellBeing (Bernardino, 2018; Martins, 2018), and it is articulated with research

studies and projects where emotional and biometric information is collected from digital content consumers.

1.4 Contributions

This work's contributions are:

1. Conceptual framework and State of the Art review;
2. Redesign and refactoring of the Media4WellBeing application, now adapted to mobile devices;
3. Design and implementation of the emoJar system in its entirety (i.e., its presentation, business logic, data management, features, and mechanisms);
4. Design and implementation of the digital content's saving and self-assessment mechanisms;
5. Design and implementation of the emoJar view and all its filtering mechanisms;
6. Design and implementation of all the system's emotion representations;
7. Conduction of a system evaluation with users, and subsequent analysis of its results;
8. Writing and publication of a paper and poster presented at the TVX 2019 conference, where we idealize the form and functioning of the emoJar system (Carvalho & Chambel, 2019).

1.5 Work's Development Plan

Initially, our focus was on the survey of scholarly sources (books, journal articles, dissertations, and theses) in order to learn more about the various theories and concepts that we would come to work with (presented in this document's Chapter 2). At the same time, we did our research on existing applications, platforms, and projects in order to survey the state of the art (presented in Chapter 3). After this, we had a relatively clear idea of what we would like to explore with our work, and so we started to design the emoJar system's interface and overall behavior, while also exploring the set of tools and technologies that could be used to implement it. Eventually, we started developing the system, and since the opportunity to write an article about the solution we were developing at the time arose, we set out to do it, deviating slightly from our original plan (Figure 1.1a vs. Figure 1.1b).

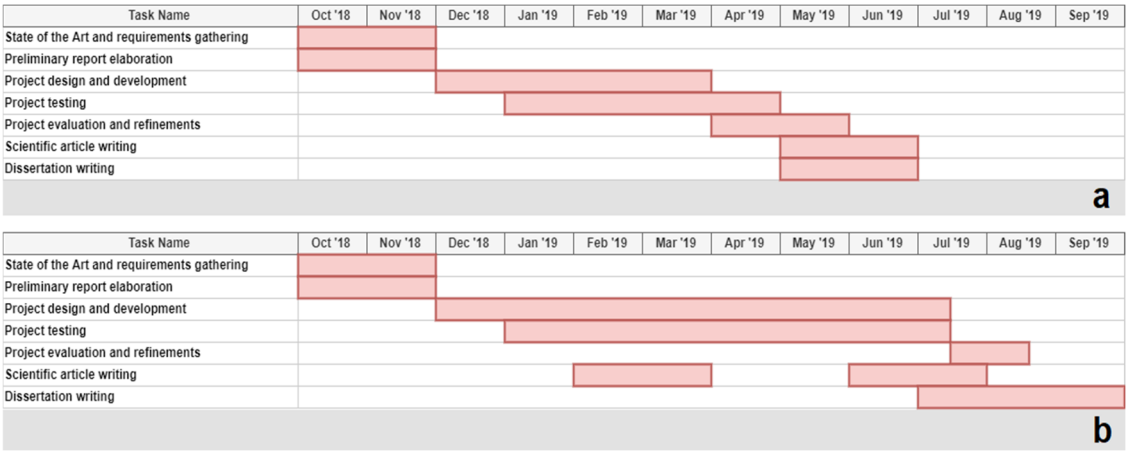

Figure 1.1 – Gantt charts with this work's a) original and b) followed schedules.

With the writing of that article – but especially with the emergence of unexpected health-related setbacks and the Software Verification and Validation course, whose theoretical and practical classes, 3 projects, and exam deprived us of some time – the system's development slowed down and dragged on for longer than initially expected, and so did its testing, user evaluation, and refinement phases. Eventually, we got to evaluate and refine our system according to the collected feedback, and once that was done, we concluded this document's writing.

1.6 Document Structure

This document is comprised of 7 chapters, with each chapter being divided into several sections:

- Chapter 1 (Introduction) describes the proposed work's motivation, objectives, context, contributions, planning, and structure of this document;
- Chapter 2 (Conceptual Framework) reviews the concepts and studies that serve as the foundation for our project;
- Chapter 3 (Related Work) focuses on the already existing tools, applications, platforms, and work that relates to our own;
- Chapter 4 (Design Rationale) describes the design choices made for the emoJar system;
- Chapter 5 (Implementation) focuses on the emoJar system's implementation aspects;

- Chapter 6 (User Evaluation) presents the objectives, context, methodology, participants, and results of the emoJar system's user evaluation;
- Chapter 7 (Conclusions and Future Work) presents this dissertation's final considerations and future work.

Chapter 2

Conceptual Framework

In this chapter, a review of studies and concepts closely related to this work's theme is presented, with the following topics being covered: 1) wellbeing, its dimensions, the scientific areas that deal with it, what a Happiness Jar is and how it relates to and impacts wellbeing, and how digital content can promote wellbeing; 2) the history, definitions, and intricacies of emotions; 3) the existing and most relevant models of emotion; 4) color-emotion associations; 5) how we experience, express, and may recognize emotions; and 6) some of the existing physiological and mobile devices' sensors, how they work, and for what purposes they are or can be used.

2.1 Wellbeing

Back in 1871, an English writer named Charles Lutwidge Dodgson – better known by his pen name Lewis Carroll – published a sequel to his world-famous novel "Alice in Wonderland" called "Through the Looking-Glass" (Carroll, 1999). In it, Alice – the novel's main character – would come to meet a character named Humpty Dumpty, who at some point turns to Alice and says "When I use a word, it means just what I choose it to mean – neither more nor less.", suggesting that the meaning of any given word lies with its user. In a sense, the term "wellbeing" mirrors Humpty Dumpty's remarks because, depending on who you ask, "wellbeing" might mean a number of things – e.g., to some it might equate to having the necessary financial resources to acquire one's objects of desire (e.g., the latest smartphone), while to others it might equate to a life of meaning and joy.

This example goes to show that there are two conceptual, and somewhat related approaches to wellbeing: the first is the objective (economical) approach, where

wellbeing is defined in terms of quality of life indicators like one's income, consumption patterns, assets, education, health, political voice, and social network (objective wellbeing) (Conceição & Bandura, 2008); the second – largely influenced by an American psychologist, professor, and writer named Edward F. Diener – is the subjective (psychological) approach, where wellbeing is defined in terms of individual's own evaluations of their lives (i.e., their life satisfaction) and their affective balance (i.e., the difference between the amount of times positive and negative emotions are experienced) (subjective wellbeing) (Diener, 2000; Diener et al., 2009). Because it is a multifaceted concept, defining wellbeing can be quite challenging (Dodge et al., 2012) – still, one might ultimately consider wellbeing as having the necessary physical, psychological, and social resources to meet a particular physical, psychological, and/or social challenge (Dodge et al., 2012). In the following subsections, we briefly describe 3 fields that directly or indirectly deal with the psychological component of wellbeing and that are related to our work, and we discuss digital content's impact on the psychological wellbeing of those who consume it.

2.1.1 Positive Psychology

A field that concerns itself with the subjective component of wellbeing is the field of Positive Psychology. Officially established by Martin Seligman in 1998, the Positive Psychology field is one that studies what makes life most worth living (url-PositivePsychology) – namely, what factors most contribute to a life that is fulfilling, where people frequently experience positive emotions, and live within an optimal range of positive psychological and social functioning (i.e., flourish) (Fredrickson & Losada, 2005). Born out of Seligman's frustration with Psychology's overly narrow focus on the negative aspects of life, Positive Psychology posits that individuals should shift their focus away from negativity, and learn to embrace a more positive perspective, as changes in one's perspective can lead to astounding shifts in one's wellbeing. In one of Seligman's studies (Seligman et al., 2005), participants were asked to participate in an exercise in gratitude (a positive emotion) by writing down 3 things that went well each day and why, every night for one week. Results showed that this simple exercise greatly and lastingly contributed to individuals' happiness, suggesting that 1) the more we shift our focus away from negativity, the happier we will be, and that 2) the very act of reflecting on some of the good things that happen to us actually contributes to our

subjective wellbeing. With our proposed solution, and by leveraging digital content's ability to evoke memories, we hope that users can get involved in a practice that is similar to the one considered by Seligman, so that they too can hopefully experience Seligman's observed results.

2.1.2 Positive Computing

Another field that concerns itself with the subjective component of wellbeing is the field of Positive Computing. Founded by Rafael Calvo and Dorian Peters circa 2014, the Positive Computing field is centered upon the design and development of technology that is supportive of individuals' subjective wellbeing and potential (Calvo & Peters, 2014). Technology, being so pervasive and ubiquitous, has the capacity to increase individuals' stress and suffering, but it also has the less-heralded potential to improve individuals' wellbeing, and so, one of Positive Computing's most critical notions is that all technology should be designed with individuals' subjective wellbeing in mind, because "If a technology does not improve the wellbeing of individuals, society, or the planet, should it exist?" (a question posed by Calvo and Peters in their 2014 book "Positive Computing: Technology for Wellbeing and Human Potential" (Calvo & Peters, 2014)).

There are 3 approaches to Positive Computing's design of technology with individuals' subjective wellbeing in mind, which are:

1. The preventative approach, where technology is redesigned to address or prevent detriments to wellbeing;
2. The active approach (adopted in this work), where technology is designed to consider and promote the wellbeing of individuals;
3. The dedicated approach, where technology is created and totally dedicated to promoting wellbeing.

There are also 9 wellbeing factors (distributed across 3 different dimensions and summarized in Table 1.1) that one may consider and focus on when designing technology according to any of the 3 aforementioned design approaches.

Table 1.1 – Wellbeing's determinant factors.

Dimension	Determinant factors
Self (Intrapersonal)	Positive Emotions, Motivation and Engagement, Self-Awareness, Mindfulness, and Resilience
Social (Interpersonal)	Gratitude, and Empathy
Transcendent (Extra-personal)	Compassion, and Altruism

With our proposed solution, we aim to cover all 9 wellbeing factors, but the factors that we explore the most are the "Positive emotions", "Self-awareness", and "Gratitude" factors.

Ultimately, Positive Computing's end goal is that, in the future, all technology positively contributes to the growth and wellbeing of individuals, society, and the world. To do so, Positive Computing counts on the knowledge and cooperation of experts from fields such as Human Computer Interaction (a multidisciplinary field of study focusing on the design of computer technology and, in particular, the interaction between humans and computers), Psychology (a multifaceted discipline involving the scientific study of mental processes and behavior), Neuroscience (a multidisciplinary branch of biology concerned with the scientific study of the nervous system), Philosophy (a multifaceted discipline where a huge variety of general and fundamental problems – such as those connected with reality, existence, knowledge, values, reason, mind, and language – are studied), and Affective Computing (an interdisciplinary field that focuses on the study and development of systems and devices that can recognize, interpret, process, and simulate human emotion).

2.1.3 Affective Computing

The field of Affective Computing (established by Rosalind Picard in 1997 (Picard, 1997)) is an interdisciplinary field that focuses on the study and development of systems and devices that can recognize, interpret, process, and simulate human emotion.

Researchers in this Computer Science branch are driven by the desire to create systems and devices capable of interpreting the emotional state of humans, and adapt its behavior accordingly (Picard, 1997). To do so, these systems and devices have to be able to detect and recognize humans' emotional cues and information. Detecting

humans' emotional cues and information begins with the use of equipment like video cameras (to capture one's facial expressions, body posture, and/or gestures), microphones (to capture one's speech), and/or physiological sensors (to capture one's physiological responses to emotion, like changes in skin temperature and conductance). Recognizing humans' emotional cues and information then requires the extraction of meaningful patterns from the data gathered by the aforementioned equipment, which is done by machine learning techniques capable of processing this data and producing labels (e.g., "happy") or coordinates in a valence-arousal space (introduced in this document's subsection 2.3.2).

Affective Computing has many potential applications – it can be used in e-learning applications, where the presentation style of a computerized tutor changes when a learner is bored, interested, frustrated, or pleased (Graesser et al., 2005); it can be used towards the creation of social robots (i.e., autonomous robots that are able to interact and communicate with humans or other autonomous physical agents) to be used in elderly care; and/or it can be used towards the creation of a system that is able to determine the interest of a person towards a web page, multimedia presentation, or video clip. In our case – or rather, in the case of Media4WellBeing, the application we set out to extend with our work, as previously described – it is used to allow the recognition of a set of emotions experienced throughout the consumption of digital content.

2.1.4 The Happiness Jar

The "Happiness Jar" (which is also known as the "Gratitude Jar", "Good Times Jar", "Happy Jar", "Joy Jar", or "Moments Jar") is a project created by Elizabeth Gilbert – an American author best known for her 2006 memoir called "Eat, Pray, Love" (url-ElizabethGilbert) – that invites its adopters to chronicle, and later reminisce upon all the good things that came out of their lives. The way it works is simple – you grab a jar (traditionally, one that is clear, made of glass, and with a lid, like the one shown in Figure 2.1), some paper (e.g., normal white paper, or colored origami paper), and a pen. Then, at a frequency deemed appropriate (e.g., daily, weekly, or whenever something comes up), you write things that recently – or otherwise – made you happy (e.g., watching the latest episode of one's favourite show), proud (e.g., some personal achievement), or grateful. These scribbled papers are then to be read on special

occasions (e.g., at a New Year, or a birthday), or whenever its author feels the need to be reminded of the good things in their lives.

Figure 2.1 – An example of a Happiness Jar (url-HappinessJarExample).

Despite its simplicity, the idea behind the Happiness Jar is quite powerful, aligning with Seligman's research on positive emotions and wellbeing (Seligman et al., 2005):

- It encourages individuals to reflect on their lives, and learn how to identify and appreciate small moments in time which were good, and positively contributed to their wellbeing;
- By bringing these small moments back into their awareness, and by writing them down, individuals get to mentally reexperience those moments, and all that followed (e.g., the sensation of ecstasy, the joy of achieving some goal);
- It may be uplifting to see that one's Happiness Jar is starting to fill up with good moments and memories. This, in turn, might encourage its owners to more oftenly indulge in the activity mentioned in the previous point, and to seek new opportunities and things to feel happy, proud, and grateful about.

Overall, the Happiness Jar serves as a great time capsule of life's best and can promote individuals' psychological wellbeing. On the other hand, it is somewhat limited in its ability to support users in terms of flexibility (e.g., at some point, it might be difficult to find a particularly meaningful entry that is lost amidst other entries), portability, type of content (i.e., scribbled papers and other tokens – like a concert ticket, for example – are the only things that users may store within the jar), and emotional awareness (i.e., if the jar's owner decides to color-code each entry, and the jar

starts to fill up, it may become hard to ascertain how many entries relate to a sense of happiness, pride, or gratefulness).

2.1.5 Digital Content's Impact on Wellbeing

Nowadays, digital content (namely, video, audio, images, and text) consumption occupies a significant share of our waking hours, so it is only natural that questions pertaining to its impact on individuals' subjective wellbeing start to arise. Most research on digital content has focused on understanding its detrimental effects (e.g., how digital content might trivialize and/or promote violence (Huesmann et al., 2003) and sexual aggression (Peter & Valkenburg, 2010), reinforce gender and ethnic stereotypes, and perpetuate problematic body ideals (Eyal & Te'Eni-Harari, 2013)). More recently, however, research has started to explore the potential benefits of digital content and its consumption on individuals' subjective wellbeing – among other things, digital content and its consumption can provide relief from stress and daily hassles, and facilitate one's physical and psychological recovery after a long working day (Reinecke et al., 2011). Anecdotally, it can remind and/or have us reflect upon moral virtues and the purpose of life; it can impel us to be more altruistic (i.e., act in a way that promotes someone else's wellbeing); it can teach us to be more empathetic, compassionate, and tolerant towards those who differ from us; it can help us let go of feelings of resentment or vengeance towards a person or group who has harmed us; it can make us experience a range of positive emotions, like joy, pride, awe, and contentment; and it can help us learn to be more appreciative of the life we have, to be grateful for the good things in it, however small.

Upon reflecting on this subject, an important question arises – how does one go about measuring the impact that some digital content might have had on an individual? Currently, websites hosting many different kinds of digital content (like YouTube, Spotify, reddit, and even Facebook) use simple metrics like the number of views, shares, likes, dislikes, comments, and reactions to determine the reach and popularity of any given digital content, but these seldomly reflect the intricacies of individuals' experiences with that digital content (e.g., what emotions were experienced throughout the digital content's consumption, and more importantly, why). It is with that in mind that in Chapter 4 we will present the mechanisms we have developed to allow individuals to describe in what ways and why some content was memorable, capable of

making them experience any number of emotions, and capable of contributing to their subjective wellbeing.

2.2 History, Definition, and the Intricacies of Emotion

Ever since William James – an American philosopher and psychologist that is widely regarded as the founder of American psychology – tried to come up with an authoritative answer to what the term "emotion" truly means in his aptly named, 1884 book "What is an Emotion?" (James, 1884), several researchers came forward with their own renditions of this concept and, in doing so, the number of proposed scientific definitions gradually grew to a point where counting all of them would be a Herculean task (Kleinginna & Kleinginna, 1981). Despite the fact that there is no universally accepted definition, researchers seem to agree on two things:

1) All emotions are reactions to some internal or external event (i.e., they are reactions to something we thought about or remembered, or something we are observing or experiencing) (Brave & Nass, 2009);
2) All emotions encompass physiological, affective (i.e., relating to feelings[1], moods[2], and attitudes), behavioral, and cognitive components (Brave & Nass, 2009).

Traditionally, emotions are dichotomously classified as positive or negative – according to Barbara Fredrickson's broaden-and-build theory (Fredrickson, 2004), positive emotions are said to increase the range of thoughts and actions we might consider in a given situation (e.g., joy sparks the urge to play, and interest makes us want to explore and learn more about something), while negative emotions are said to narrow our attention and urge us to act in a specific way (e.g., fear alerts us to danger and prompts us to flee to safety, and sadness causes us to withdraw). Positive emotions have also been shown to foster improved health, coping ability (i.e., resilience), physical and psychological wellbeing, social relationships, work life, and even income (Danner et al., 2001; Tugade et al., 2004; Lyubomirsky et al., 2005; Ong et al., 2006), while negative ones have been shown to be detrimental to physical and psychological health (Howell et al., 2007; Kok et al., 2013) and many other aspects of life (based on

[1] A term that is usually reserved for the conscious, subjective experience of emotion (url-APA)

[2] Less specific, less intense emotional states that may be prompted for no apparent reason, and may last for some time (url-APA)

anecdotal evidence). That being said, positive and negative emotions can also have conflicting consequences – a positive emotion can lead to negative outcomes (e.g., interest might put us in difficult and/or dangerous situations), and a negative emotion can lead to positive outcomes (e.g., sadness might have us reflect about the situations and/or thought patterns that make us experience it, which might have us put some positive changes into practice) (An et al., 2017).

Another aspect of emotions is how all of them, to a greater or lesser extent, bring about certain bodily and physiological changes (e.g., changes in facial expression, voice, and posture, in the case of bodily changes, and changes in brain activity, heart rate, and breathing variability, in the case of physiological changes) – changes that may reveal themselves useful when trying to design systems and applications that enhance individuals' experiences with digital content by, for example, making them more aware of how their bodies respond to the experience of emotions (an angle that we explore).

2.3 Models of Emotion

Despite all the scientific discourse regarding the exact meaning of the term "emotion" (Kleinginna & Kleinginna, 1981), one can easily split emotion researchers and theorists into two camps: those who take a more categorical approach to emotion, and those who take a more multidimensional approach to emotion. As such, there are but two types of models of emotion – categorical models, and dimensional models. Since they help us differentiate, categorize, and understand emotions and how they may relate, what follows is a quick rundown of each type's most relevant models of emotion.

2.3.1 Categorical Models of Emotion

Categorical – or discrete – models of emotion assume a finite number of basic emotions that describe emotional reactions which are innate and universal to all human beings (Ekman, 1992). One such model, encompassing six basic emotions (anger, disgust, fear, happiness, sadness, and surprise) based on facial expressions that were recognized across many different cultures (even secluded, preliterate ones), came out of Paul Ekman's multicultural research on emotions and emotional expression (Ekman, 1992) (Figure 2.2).

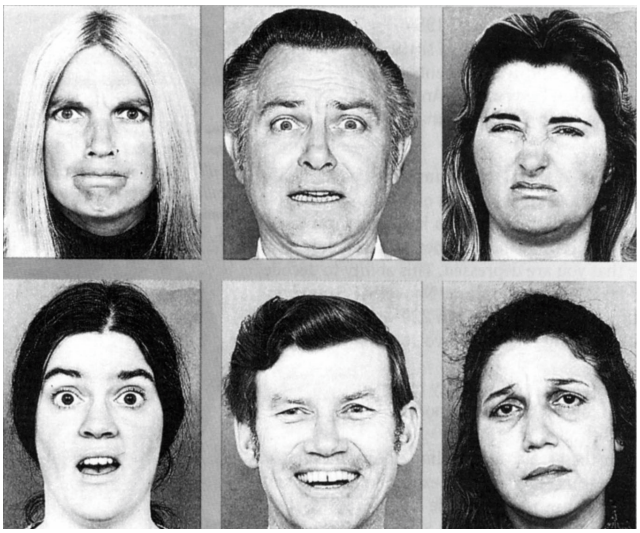

Figure 2.2 – Ekman's six basic emotions, facially expressed (from left to right, and top to bottom): anger, fear, disgust, surprise, happiness, and sadness (url-EkmanSix).

In later work (Ekman, 1999), Ekman would come to expand upon this set of six basic emotions with eleven new ones – amusement, contempt, contentment, embarrassment, excitement, guilt, pride in achievement, relief, satisfaction, sensory pleasure, and shame.

Some other categorical models of emotion exist, such as the tree-structured one proposed by W. Gerrod Parrott's in (Parrott, 2001) (Figure 2.3), but Ekman's is the one that much of the work on emotions seems to build up on.

Primary emotion	Secondary emotion	Tertiary emotion
Love	*Affection*	*Adoration · Fondness · Liking · Attraction · Caring · Tenderness · Compassion · Sentimentality*
	Lust/Sexual desire	*Desire · Passion · Infatuation*
	Longing	*Longing*
Joy	*Cheerfulness*	*Amusement · Bliss · Gaiety · Glee · Jolliness · Joviality · Joy · Delight · Enjoyment · Gladness · Happiness · Jubilation · Elation · Satisfaction · Ecstasy · Euphoria*
	Zest	*Enthusiasm · Zeal · Excitement · Thrill · Exhilaration*
	Contentment	*Pleasure*
	Pride	*Triumph*
	Optimism	*Eagerness · Hope*
	Enthrallment	*Enthrallment · Rapture*
	Relief	*Relief*
Surprise	*Surprise*	*Amazement · Astonishment*
Anger	*Irritability*	*Aggravation · Agitation · Annoyance · Grouchy · Grumpy · Crosspatch*
	Exasperation	*Frustration*
	Rage	*Anger · Outrage · Fury · Wrath · Hostility · Ferocity · Bitterness · Hatred · Scorn · Spite · Vengefulness · Dislike · Resentment*
	Disgust	*Revulsion · Contempt · Loathing*
	Envy	*Jealousy*
	Torment	*Torment*
Sadness	*Suffering*	*Agony · Anguish · Hurt*
	Sadness	*Depression · Despair · Gloom · Glumness · Unhappiness · Grief · Sorrow · Woe · Misery · Melancholy*
	Disappointment	*Dismay · Displeasure*
	Shame	*Guilt · Regret · Remorse*
	Neglect	*Alienation · Defeatism · Dejection · Embarrassment · Homesickness · Humiliation · Insecurity · Insult · Isolation · Loneliness · Rejection*
	Sympathy	*Pity · Mono no aware · Sympathy*
Fear	*Horror*	*Alarm · Shock · Fear · Fright · Horror · Terror · Panic · Hysteria · Mortification*
	Nervousness	*Anxiety · Suspense · Uneasiness · Apprehension (fear) · Worry · Distress · Dread*

Figure 2.3 – Parrot's categorical model of emotion (in table form, as its tree-structured form would be too extensive; url-EmoCategorizations).

Overall, categorical models of emotion benefit from the fact that they deal with a finite number of basic emotions, making them easy to handle and interpret.

2.3.2 Dimensional Models of Emotion

Dimensional models of emotion make an attempt at characterizing human emotions by defining where they lie on a two or three-dimensional space, whose dimensions typically represent valence (how positive or negative those emotions are), arousal (how intense those emotions are), and sometimes dominance (how in control of those emotions one can be).

While several dimensional models of emotion have been developed – such as the PANA model of emotion (Watson & Tellegen, 1985), the Vector model of emotion (Bradley et al., 1992), the Ortony-Clore-Collins appraisal model of emotion (Ortony et al., 1994), Lövheim's cube of emotion (Lövheim, 2012), and the PAD Emotional State model (Bakker et al., 2014) – the most prominent ones are the Circumplex model of emotion (Russell, 1980), Robert Plutchik's Wheel of Emotions (Plutchik & Kellerman, 1980), and the Geneva Emotion Wheel (Scherer et al., 2013).

Created by James Russell back in 1980, the Circumplex – or Russell's – model of emotion advocates that emotions can be distributed in a two-dimensional circular space that, at its core, has valence and arousal as its dimensions, and eight distinct categories of emotion – arousal, contentment, depression, distress, excitement, misery, pleasure, and sleepiness – to work from (Russell, 1980) (Figure 2.4).

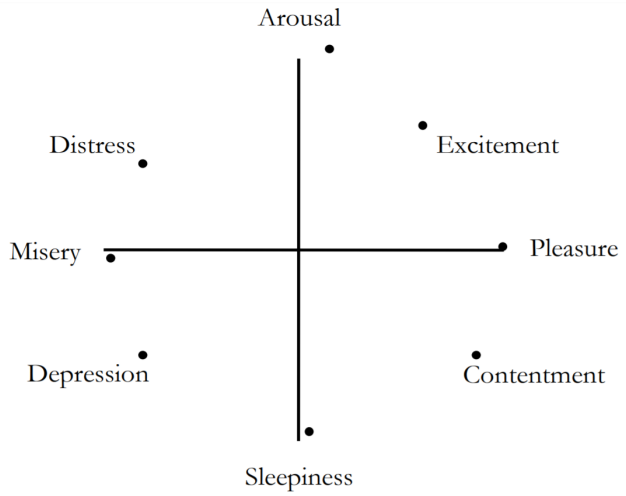

Figure 2.4 – The Circumplex model of emotion, with its eight categories of emotion (Russell, 1980).

With the Circumplex's horizontal axis being representative of valence, and the vertical axis being representative of arousal, it is possible to plot emotional states at any level of these two dimensions (as shown in Figure 2.5, where 28 emotion-denoting adjectives – suggested by James Russell – are plotted around the 8 aforementioned categories).

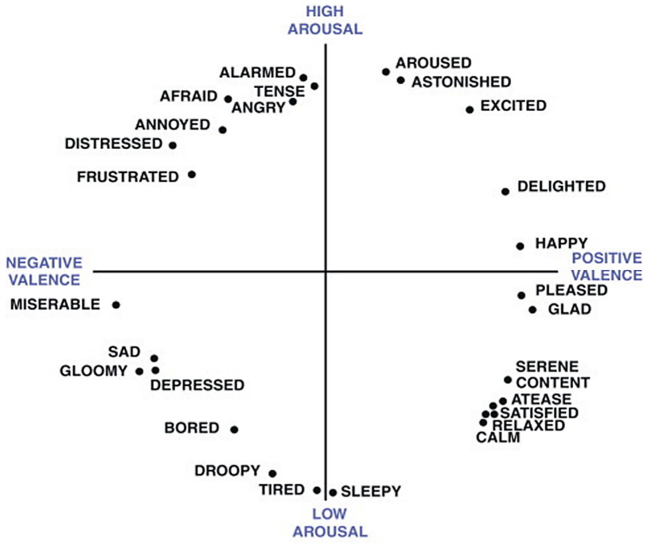

Figure 2.5 – The Circumplex model of emotion, with 28 distinct emotions plotted on it (Russell, 1980).

Created by Robert Plutchik back in 1980 (Plutchik & Kellerman, 1980) to illustrate the various relationships among emotions, the Wheel of Emotions (or Emotion Wheel) is a two-dimensional model of emotion (left of Figure 2.6) that has several noteworthy characteristics:

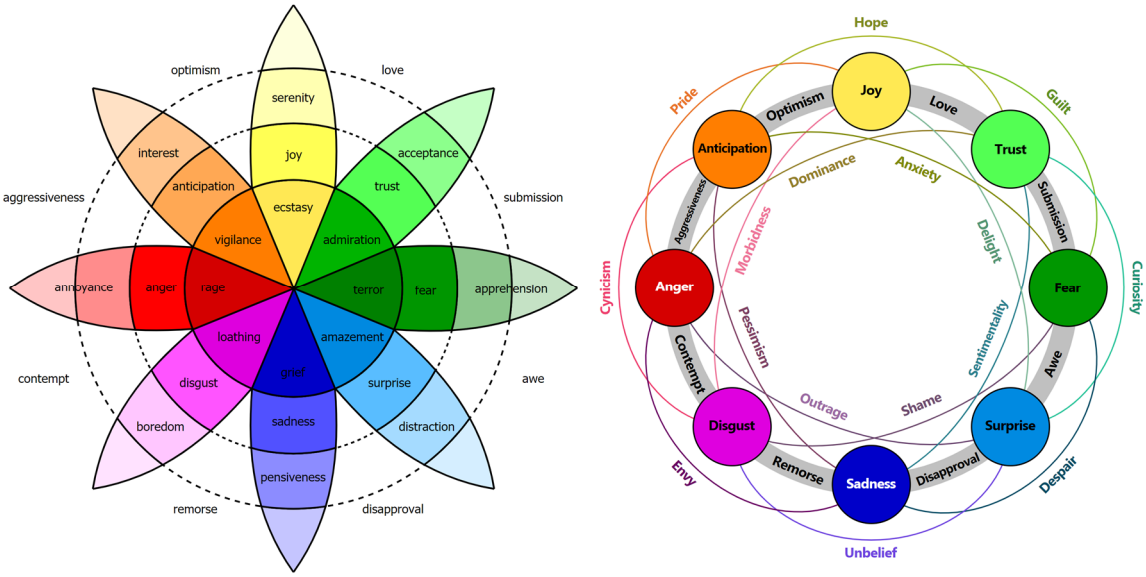

Figure 2.6 – Plutchik's Wheel of Emotions (to the left), and all of its secondary emotions (to the right), both from (url-EmoCategorizations).

- It considers three dimensions – valence (e.g., joy is a positive emotion), arousal (e.g., ecstasy is the most intense form of joy), and similarity (e.g., joy, serenity, and ecstasy are similar emotions);
- It comprehends eight primary emotions – joy, trust, fear, surprise, sadness, disgust, anger, and anticipation – which occupy the second "ring" of the wheel (starting from its core);
- Each emotion stands across its polar opposite (e.g., joy stands across sadness);
- Like the colors that represent them, primary emotions can be expressed at different intensities, with the intensity of each emotion increasing as one moves towards the wheel's core, and decreasing as one moves away from it (i.e., the darker the shade, the more intense the emotion; e.g., ecstasy is the most intense form of joy, and serenity is the mildest);
- Secondary emotions (24 of them, to the right of Figure 2.6) are created by blending two of the 8 primary emotions that are standing one, two, or three "petals" apart.

Created by Klaus Scherer in 2005 (Scherer, 2005), the Geneva Emotion Wheel (or GEW) was created to be used as a tool to obtain a person's self-report of emotions elicited by particular events and/or objects (Scherer, 2005; Scherer, 2010; Scherer et al., 2013) (Figure 2.7). It is somewhat similar to Plutchik's Emotion Wheel, although it has the following differences:

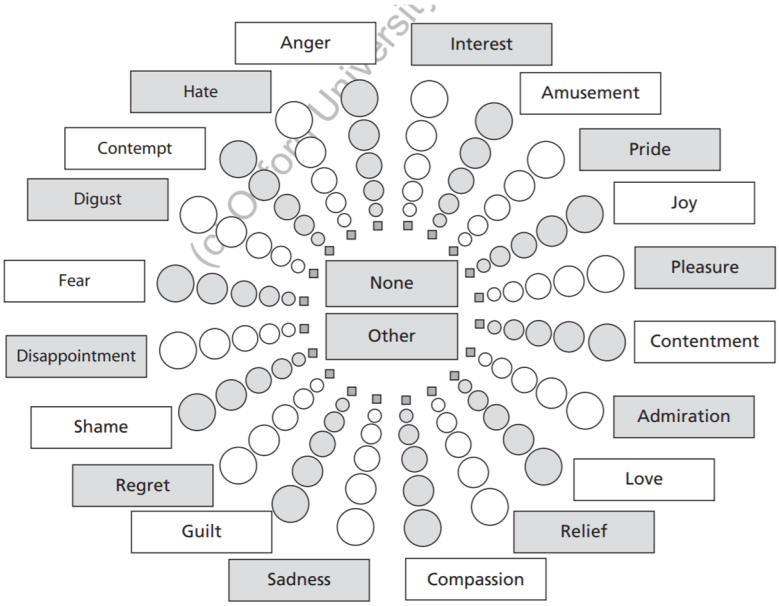

Figure 2.7 – The Geneva Emotion Wheel (Scherer et al., 2013).

- The GEW considers valence, arousal, and dominance/control as its dimensions, whereas Plutchik's Wheel of Emotions considers valence, arousal, and similarity;
- In the GEW, intensity is reversed – the intensity of each emotion increases as one moves away from the wheel's core and into its outer layers (i.e., the larger the circle, the more intense the emotion), whereas in Plutchik's Wheel of Emotions, the intensity of each emotion increases as one moves towards the wheel's core and into its inner layers;
- The GEW allows one to select "No Emotion (felt)", or "Other Emotion (felt)", giving respondents the ability to freely express themselves about a particular event and/or object, whereas Plutchik's Wheel of Emotions does not.

In general, dimensional models of emotion benefit from the fact that they make it possible to determine where several emotions lie on a multidimensional space that takes concepts like valence and arousal into consideration.

2.4 Colors and Emotion

The relationship between colors and emotion is one that has been studied extensively throughout the years. In their 1994 study on color-emotion associations, Boyatzis & Varghese found that children (30 boys and 30 girls between 4 and 7 years old) often associate bright colors (i.e., blue, green, pink, purple, red, and yellow) with positive emotions (e.g., happiness), and dark colors (i.e., black, brown, and gray) with negative emotions (e.g., sadness) (Boyatzis & Varghese, 1994). In a similar study, Hemphill found that individuals (40 college-aged adults, 20 male, 20 female) frequently associate bright colors (e.g., white, pink) with positive emotions (e.g., happiness), and dark colors (e.g., black, brown) with negative emotions (e.g., anxiety, sadness) (Hemphill, 1996). In her doctoral dissertation, Gohar demonstrated that color is an important perceptual feature of six distinct emotions (namely, anger, disgust, fear, happiness, sadness, and surprise) (Gohar, 2008), and that individuals recurrently associate colors with emotions – by asking 120 undergraduate students between 18 and 53 years old to provide a minimum of 5, and a maximum of 8 different perceptual features for each emotion following the question "If (e.g., anger) was an object or something tangible, palpable,

that you could hold in your hands, how would you describe it or what would it look like?", Gohar would come to find that, for example, anger (a negative emotion) would often be described as red, and disgust (also a negative emotion) as green.

One thing that has been made clear by these examples is that colors are not exclusively tied to one specific emotion – they can be associated with distinct, polarizing emotions (Boyatzis & Varghese's green with happiness vs. Gohar's green with disgust). According to Kaya & Epps' research on color-emotion associations (Kaya & Epps, 2004), this peculiarity could be explained by an individual's color preferences and past experiences, as well as color symbolism (i.e., what a color means to a particular person or culture). In their 2004 study, Kaya & Epps asked 98 college students (44 male, 54 female) to indicate and justify their emotional responses to 5 principal hues (i.e., blue, green, purple, red, and yellow), 5 intermediate hues (i.e., blue-green, green-yellow, purple-blue, red-purple, and yellow-red), and 3 achromatic (i.e., lacking hue) colors (i.e., black, gray, and white) obtained through Munsell's color system (url-WikiMunsell), a color space that specifies colors based on 3 perceptual dimensions, which are hue (the color in question), brightness (how light or dark that color is), and saturation (how intense that color is). What they found was that e.g., green (a color that was associated with disgust by most of Gohar's study participants) was generally associated with emotions of happiness and hope, as it reminded participants of nature and trees, as was yellow, which was largely associated with emotions of happiness and excitement, as it reminded participants of the sun and the summer. Interestingly, the intermediate hue of green-yellow brought about the highest number of negative emotional responses of all intermediate hues, as participants frequently associated it with disgust and feelings of sickness. Purple was somewhat disliked by participants (a matter of preference), despite recurrent associations with children and laughter. White, one of the 3 achromatic colors used for this study, was regularly associated with hope, peace, and innocence, as it reminded some respondents of brides, doves, and cotton – it also elicited negative emotions of boredom and loneliness. The associations made for this color would certainly vary if this research was conducted in Eastern countries like China and Korea, where white is the color of death and mourning.

Back in 2006, designer and visual researcher Orlagh O'Brien distributed a simple, 5-question quiz to a total of 250 people (from over 35 countries, and between the ages of 6 and 75) asking them to describe anger, fear, joy, love, and sadness through words, drawings, and colors (O'Brien, 2006). One question asked respondents to describe, through the use of words, what made them feel each of the aforementioned emotions; three of them asked respondents to draw how they felt these 5 emotions in the body, their exact spot, and their direction; and another question asked respondents to select and jot down the color they associated with each emotion from the provided color palette, comprised of 170 distinct colors.

From this quiz's results, O'Brien created an online graphic interpretation to which she named Emotionally}Vague (url-EmotionallyVague). These were the color-emotion associations made by all 250 participants (Figure 2.8):

Figure 2.8 – The color-emotion associations made by O'Brien's study participants (url-EmotionallyVague).

As made evident by all of the reviewed research, color-emotion associations exist, and they vary significantly between individuals, often being deeply personal and rooted in one's own experience or culture. In Chapter 4, we will have the opportunity to discuss the implications that this conclusion had on the system that we propose.

2.5 Experience of Emotion

To have one's heart race when angry, or to have one's palms sweat when anxious is to experience emotion and all of its associated bodily changes (Nummenmaa et al., 2013).

Humans experience a really broad set of emotions, and every single one of them – to a greater or lesser extent – brings about specific physiological changes (such as increased heart rate, muscle tightening, or chemical release, for example). These are involuntarily brought about by the autonomic nervous system (or ANS) (Richter & Wright, 2013), a part of our nervous system (i.e., a complex network of nerve cells and fibers capable of transmitting specific signals to and from different parts of the body) that is responsible for autonomously controlling and regulating several body parts and processes (like heart rate, respiratory rate, digestion, pupillary response, and sexual arousal, to name a few).

This system – the ANS – is composed by two complementary subsystems: the sympathetic nervous system (or SNS), which gets our body ready for stressful events or conditions; and the parasympathetic nervous system (or PSNS), which 1) gets our body back into a relaxed state, and 2) controls our body's processes during that relaxed state. For instance, if one's facing a threat and needs to flee, the sympathetic nervous system will quickly get one's body ready for it by increasing heart rate, dilating the pupils, expanding the airways, and depressing digestion. Once the threat has subsided, the parasympathetic nervous system will then start to dampen these responses to threat, slowly returning one's body to its normal, composed state.

Having been established by several authors that emotions and bodily feedback go hand in hand (James, 1894; Kreibig, 2010; Nummenmaa et al., 2013) – with this bond being universal to all human beings, regardless of culture (Nummenmaa et al., 2013) – it becomes possible to determine and measure one's emotional experience by way of manual or automatic analysis of autonomic measures (e.g., brain, heart, and/or muscle activity) and one's emotional expression (e.g., vocal characteristics, and facial and/or body behavior) – as shown by (Nakasone et al., 2005; Kim & Andre, 2008; Canento et

al., 2011; Murugappan & Murugappan, 2013; Gouizi et al., 2014; Valenza & Scilingo, 2014; Guendil et al., 2015; Soleymani et al., 2015) – and also by way of self-report (e.g., "I experienced a rush of happiness, and felt my heart race when that happened").

2.6 Expression of Emotion

To scowl and scream when angry, or to cry and stutter when sad, is to express emotion – and to express emotion is to verbally and nonverbally communicate one's particular emotional experience.

2.6.1 Verbal Expressions of Emotion

Studies have shown that speech can impart much more than its worded content – it can also express emotion through its pitch (i.e., relative highness or lowness of the voice), volume (i.e., how loud or subdued the voice is), rate (i.e., the speed by which a speech is delivered; e.g., an anxious person might deliver a speech at a higher-than-average rate), tone (i.e., the attitude of the voice; e.g., a sarcastic tone of voice is taunting), intensity, and duration (Frick, 1985; Murray & Arnott, 1993; Chuenwattanapranithi et al., 2007). Additionally, other studies have found that 1) the emotion being expressed through someone's speech is perceivable even when the utterance is emotionally ambiguous, or when the listener does not know the language, and that 2) screams, sobs, and sighs (among other utterances) can be powerful indicators of the speaker's emotions.

2.6.2 Nonverbal Expressions of Emotion

Scientific research on nonverbal expressions of emotion began in 1872 with the publication of Charles Darwin's book "The Expression of the Emotions in Man and Animals" (Darwin & Prodger, 1998). In it, Darwin would go on to claim that, with emotions being innate to all human beings, facial expressions of emotion are the same wherever one happens to go to in the world. About a century later, this claim would go on to receive its first empirical backing, with Ekman & Friesen finding that people living in remote regions of the world, such as Papua New Guinea (Oceania) and Borneo (Southeast Asia), were just as capable of identifying six different emotions based on facial expressions as people from Argentina, Brazil, Chile, Japan, and the United States of America (the first countries where Ekman and Friesen tested Darwin's claim)

(Ekman et al., 1969; Ekman & Friesen, 1971). Not only did this finding – that people from all around the globe, including members of geographically and culturally isolated societies, were able to recognize certain nonverbal displays of emotions – become the strongest evidence supporting Darwin's claim, it also gave way to the creation of the Facial Action Coding System (or FACS), which was developed to describe all manner of anatomically possible facial expressions of emotion by deconstructing each one into its specific muscle movements (called Action Units, or AUs) (Tian et al., 2001) (Figure 2.9).

NEUTRAL	AU 1	AU 2	AU 4	AU 5
				
Eyes, brow, and cheek are relaxed.	Inner portion of the brows is raised.	Outer portion of the brows is raised.	Brows lowered and drawn together	Upper eyelids are raised.
AU 6	AU 7	AU 1+2	AU 1+4	AU 4+5
				
Cheeks are raised.	Lower eyelids are raised.	Inner and outer portions of the brows are raised.	Medial portion of the brows is raised and pulled together.	Brows lowered and drawn together and upper eyelids are raised.
AU 1+2+4	AU 1+2+5	AU 1+6	AU 6+7	AU 1+2+5+6+7
				
Brows are pulled together and upward.	Brows and upper eyelids are raised.	Inner portion of brows and cheeks are raised.	Lower eyelids cheeks are raised.	Brows, eyelids, and cheeks are raised.

Figure 2.9 – Facial Action Coding System: upper face Action Units and some combinations (Tian et al., 2001).

Since then, many other studies have replicated the findings made by Ekman and Friesen (all of which can be reviewed in (Matsumoto, 2001)), providing further evidence to Darwin's claim on the universality of facial expressions of emotion.

Several studies on bodily expressions of emotion have also been executed, showing that emotion can just as accurately be deduced from an individual's static posture (namely, one's head and spine position) (Schouwstra & Hoogstraten, 1995; Wallbott, 1998), movement (Montepare et al., 1987; Hicheur et al., 2013), gestures (Wallbott, 1998), and certain involuntary displays of emotional experience (e.g., one's face turning beet red when angry) (Nummenmaa et al., 2013).

2.7 Recognizing Emotions in Humans

Since humans experience a really broad set of emotions (which bring about specific physiological changes), and express these emotions through several channels (namely, their voices, faces, and/or bodies), emotions can be recognized in a number of ways. As our voices and faces represent two of the most obvious (as in discernible, pronounced) channels of emotional information, the most researched methods of emotion recognition involve speech and facial expression (Garcia-Garcia et al., 2017) – however, one major argument can be made against the isolated, or combined use of speech and facial expressions as means of recognizing emotions, which is the fact that individuals might, for whatever reason, deliberately manipulate their utterances or facial expressions to mask the emotions they actually feel (e.g., a monotone voice or a blank facial expression to conceal joy), which inevitably has us questioning 1) how accurate the recognized emotion is, and 2) how reliable the emotion recognition system at use can possibly be.

By taking additional difficulties into consideration (such as isolating speech from ambient background noise in the case of emotion recognition from speech, and making sure that the individual's face is adequately lit and uncovered at all times in the case of emotion recognition from facial expressions), a strong set of arguments in favor of emotion recognition based on physiological data gathered by physiological sensors starts to form. On top of that, physiological responses to emotion (e.g., increased heart rate as a result of experiencing emotion) are more robust to any possible masking, as they are directly controlled by the autonomic nervous system (which is to say that physiological responses to emotion are involuntary and harder to manipulate). While the current form and method of application of most physiological sensors is anything but natural and intuitive, recent advances in wearable computing have made the inconspicuous incorporation of physiological sensors into articles of clothing and clothing accessories possible (as is the case with smart shirts, smartwatches, and smartbands) which, in addition to the inexpensive integration of cameras and other non-physiological sensors into most mobile devices, has created new opportunities to ingeniously gather and process raw physiological data without the use of obtrusive equipment, paving the way towards more accessible and inconspicuous emotion recognition.

2.7.1 Physiological Sensors and Physiological Data

Going by all the research on what the most common physiological changes associated with a particular emotion are (Calvo et al., 2015), and seeing as how physiological sensors are devices capable of gathering physiological data that is reflective of these physiological changes, what follows is a brief overview of several physiological sensors, and how they may help us determine an individual's emotional state (on a more dimensional note):

- **Electroencephalography (or EEG) sensor**: Measures the electrical activity of the brain through a number of electrodes placed along the surface of the head (scalp and forehead). Its signals have been shown to help recognize and distinguish between positive and negative emotions (valence), and different arousal levels (Murugappan & Murugappan, 2013; Soleymani et al., 2015);

- **Electrocardiography (or ECG) sensor**: Measures the electrical activity of the heart over a period of time through electrodes placed over the surface of the chest. Its signals provide information about one's heart rate (HR), heart rate variability (HRV), and inter-beat intervals (IBI), which allows us to recognize and differentiate between positive and negative emotional states (valence) (Money et al, 2009), and different arousal levels (Zuidhof, 2013);

- **Blood Volume Pulse (or BVP) sensor**: Measures one's heart rate (HR) and blood pressure (BP) based on the volume of blood passing through the tissues of a specific area (either the pads of the fingers, or the earlobes) with each heartbeat (i.e., pulse). This sensor – also known as a photoplethysmography (or PPG) sensor – allows us recognize and differentiate between positive and negative emotional states (valence) (Money et al, 2009) – for example, when someone's experiencing fear, blood flow to the extremities is restricted (as it goes to major muscle groups), and when someone's experiencing joy, the volume of blood pumped to the extremities is increased. Seeing as how BVP sensors are sensitive to variations in placement (e.g., if the sensor is bumped or slips, the signal might be disturbed or entirely lost) and motion (e.g., if the sensor's wearer raises his hand, blood flow to his finger will be diminished, and the signal might be

disturbed), they may require the use of a redundant or complimentary sensor. In recent years, algorithms capable of using the camera of commercially available computers and mobile devices to effectively estimate this sensor's measures have been developed (Pelegris et al., 2010);

- **Electromyography (or EMG) sensor**: Measures the electrical activity produced by the contraction of skeletal muscle (i.e., muscle that is attached to the bone, which is not the case with the cardiac muscle, and smooth muscle) using electrodes spread across the surface of the skin. Typically used on facial muscles as a wearable substitute for computer vision, EMG provides physiological signals that serve as a good indicator of emotional valence and arousal (Bolls et al., 2001; Nakasone et al., 2005; Canento et al., 2011; Gouizi et al., 2014; Guendil et al., 2015);

- **Electrodermal activity (or EDA) sensor**: Measures the conductivity of the skin – which increases if the skin is sweaty – through electrodes placed on the fingers, palms, and/or soles of the feet. Skin conductivity was found to vary linearly with emotional arousal (Levenson, 2006), and to help differentiate between anger and fear (Ax, 1953). EDA sensors are widely employed in emotion recognition (Nakasone et al., 2005; Canento et al., 2011; Gouizi et al., 2014; Guendil et al., 2015), but it is important to consider that the measures they provide can be influenced by external factors, such as air temperature;

- **Skin temperature (or SKT) sensor**: Measures the skin's temperature. Depending on where it is measured (face, body, or hands), skin temperature allows us to recognize and distinguish between positive and negative emotions (valence) – for example, anger makes our face's skin temperature increase, and our hand's skin temperature decrease, because it triggers the dilation of facial blood vessels, and the constriction of peripheral ones (Mittelmann & Wolff, 1943). Like the EDA sensor, it is important to consider that the measures provided by the SKT sensor can be influenced by external factors, like air temperature;

- **Respiration (or RESP) sensor**: Measures how fast and how deep a person is breathing through an elastic belt that is applied around the chest and abdomen. The measures collected by a RESP sensor serve as a good indicator of emotional valence and arousal (Boiten et al., 1994; Philippot et al., 2002; Frazier et al., 2004) – deep, full breaths are indicative of positive emotions (such as happiness), and shallow, empty breaths are indicative of negative emotions (such as fear); slow breaths are indicative of low arousal, and fast breaths are indicative of high arousal (e.g., Rapid, shallow breathing can be an indicator of panic or fear, whereas slow, deep breathing can be an indicator of a happy, relaxed resting state).

Table 2.1 – Physiological sensors, what they measure, and what they are emotionally indicative of.

Sensors	Description	Emotion Indicators
Electroencephalography (EEG)	Measures the electrical activity of the brain through the placement of electrodes across the scalp and forehead.	Valence and arousal
Electrocardiography (ECG)	Measures the electrical activity of the heart (which gives information about heart rate, heart rate variability, and inter-beat intervals) through the placement of electrodes across the surface of the chest.	Valence and arousal
Blood Volume Pulse (BVP)	Measures the volume of blood passing through the pads of the fingers or the earlobes with each heartbeat (which gives us information about heart rate, and blood pressure).	Valence
Electromyography (EMG)	Measures the electrical activity produced by the contraction of skeletal muscle through the placement of electrodes across the surface of the skin.	Valence and arousal
Electrodermal activity (EDA)	Measures the conductivity of the skin through the placement of electrodes on the fingers, palms, and/or soles of the feet.	Arousal
Skin temperature (SKT)	Measures the skin's temperature.	Valence
Respiration (RESP)	Measures how fast and how deep a person is breathing through an elastic belt that is applied around the chest and/or abdomen.	Valence and arousal

2.8 Mobile Devices' Sensors, and their Uses

Nowadays, an average mobile device – like a smartphone or a tablet – is fitted with a range of built-in sensors, tiny devices that 1) detect certain events and/or changes in the environment, and 2) power many of our mobile device's functionalities (url-MobileDeviceSensors). Of all sensors, it is important that we briefly go over how two of them – the image sensor and the accelerometer – operate, as they will be employed in our work, and mentioned in that of other individuals.

2.8.1 Image Sensor

The camera of a mobile device can be broken down into two vital components – a lens (or an assembly of lenses), and an image sensor. The former is a piece of transparent material – usually glass – that directs light onto an image sensor; the latter is a small, but intricate component – composed of millions of tiny, light-sensitive squares called pixels – that converts the light it receives into a digital image.

When the camera of a mobile device is switched on to take a picture or shoot a video, each pixel on the image sensor (Figure 2.10) – made sensitive to red, green, or blue light – records the luminosity of the light that reaches it by accumulating an electrical charge. These charges are then measured and converted into digital numbers that, once combined and processed, form an image (url-ShortCourses).

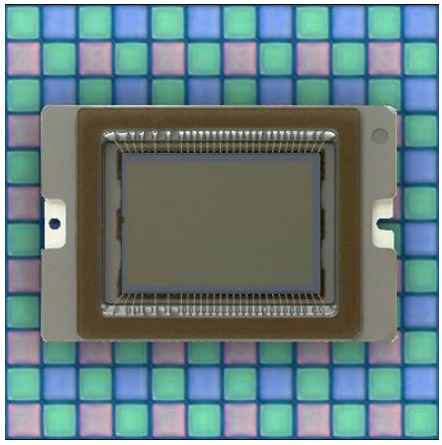

Figure 2.10 – A camera's image sensor, sitting against an enlargement of its pixels (url-ShortCourses).

As mentioned earlier, algorithms that leverage the use of a device's camera – specifically, its image sensor – to adequately estimate the heart rate of individuals have recently been developed (Pelegris et al., 2010). Similarly to how BVP sensors work, these algorithms operate by 1) having individuals place one of their fingers on the camera of their mobile device, and 2) measuring changes in the light intake or red levels of the device's image sensor, which is affected by the volume of blood passing through the individual's finger with each heartbeat (i.e., pulse).

This ingenious way of collecting physiological data is one that we adopt in our work, so as to 1) eliminate the use of obtrusive physiological sensors like the one employed for ECG data in past iterations of Media4WellBeing (covered in the "Related Work"), and to 2) lay the foundation for a more affordable and accessible emotion recognition.

2.8.2 Accelerometer

An accelerometer is a very small device that senses motion along three axes – X, Y, and Z – to keep track of a mobile device's movement and orientation.

Put simply, accelerometers are composed by microscopic structures that generate an electrical charge when stressed by accelerative forces. This electrical charge is then measured by the accelerometer and converted into values that inform our mobile devices of 1) the direction and velocity it is being moved, and 2) its orientation.

In our work, we make use of these values to create shake-based commands, similarly to what was done in an application called "HappiJar", which we will be discussing in the "Related Work" that follows.

2.9 Summary

Upon reviewing the studies and concepts presented in this chapter, it became possible to better understand 1) how psychological wellbeing relates to, and can be influenced by one's emotions; 2) how many fields concern themselves with psychological wellbeing (among which, for the purposes of our work, Positive Psychology, Positive Computing, and Affective Computing stand out); 3) how these fields inform the design and development of today's systems and applications; 4) what the Happiness Jar is and how it promotes individuals' psychological wellbeing; and 5) how digital content and its consumption has many potential benefits, among which the ability to make individuals experience positive emotions and promote their psychological wellbeing is to be noted. It also became possible to understand just how many representative models of emotion exist. The relationship between colors and emotions was also studied and led to the interesting conclusion that the emotions associated to a certain color can vary significantly between individuals due to preference and culture. The changes – inside, and out – that go along with experiencing emotions, and the means by which one might recognize these emotions, were also studied. Finally, a concise description of how two mobile devices' sensors – the image sensor and the accelerometer – operate was provided, as they will be used in our work, and mentioned in that of other individuals.

Chapter 3

Related Work

In this chapter, a survey of already existing tools, technologies, applications, and work related to our own is made, so as to point out the many contributions made by previous researchers, and to place our own contributions in the proper context. With that in mind, the following topics will be covered: 1) some of the most relevant and popular platforms that currently give individuals access to an immense and varied amount of digital content, categorized by video, audio, and images; 2) previous work that explores the emotional dimension of digital content; and 3) the applications that relate to the Happiness Jar project.

3.1 Platforms that Provide Access to Digital Content

In this setion, we go over some of the platforms that currently grant individuals access to digital content (namely, video, audio, and images, for their richness).

3.1.1 Access to video

When it comes to accessing video content, platforms like Netflix (url-Netflix), TED.com (url-TED), Vimeo (url-Vimeo), and YouTube (url-YouTube) immediately come to mind. Netflix is a massively popular streaming service that allows its subscribers to watch an assortment of entertaining movies, documentaries, and TV shows ad-free; TED.com is a website where visitors can watch “TED Talks”, videos that present a great idea or story in 18 minutes or less (save some exceptions) which 1) are filmed at TED events, 2) cover many topics, and 3) are posted for free viewing and distribution under TED’s slogan of “Ideas worth spreading”; and Vimeo as well as YouTube are popular video sharing websites where registered users can watch, rate,

share, and comment on amateur or professionally made videos, ranging from short clips, to entire movies.

All these platforms (Figure 3.1) share some similarities: video content may be watched on a small, medium-sized, or fullscreen player (i.e., fullscreen mode), with or without sound and captions, and at a given quality level or speed; videos may also be searched for (by the content's title, author, features, and tags), rated, tagged (which is how videos are then categorized), commented on, and shared on social networks (e.g., Facebook) and other platforms (e.g., reddit). Suggestions as to what video content one should watch next are also provided, and barring Netflix, users can see other users' comments while watching videos.

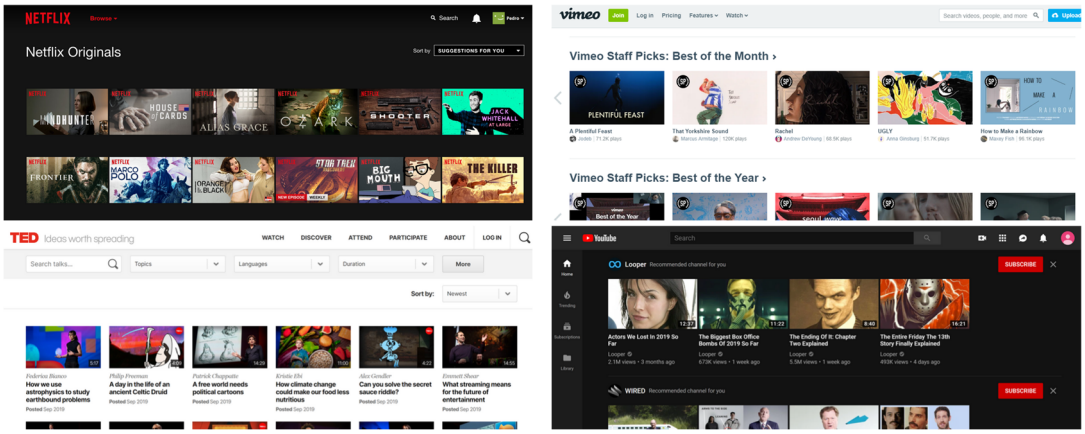

Figure 3.1 – Netflix (top left; url-Netflix), TED.com (bottom left; url-TED), Vimeo (top right; url-Vimeo), and YouTube (bottom right; url-YouTube) home pages.

3.1.2 Access to audio

When it comes to accessing audio content, Spotify (url-Spotify) is an audio streaming platform that was developed and launched by Spotify Technology in 2008. Made available in all 8 regions of the world, Spotify can be accessed on computer and mobile devices, as well as TVs, game consoles, and smart speakers, and in it, users can search for and browse through music and other kinds of audio (e.g., recordings of nature's sounds, and podcasts) according to artist, title, album, genre, playlist, or record label. Users may also share this audio content on social media, as well as create, edit, and share playlists. Very similar alternatives to Spotify exist, like Apple Music, BandCamp, Deezer, Google Play Music, Songa, Soundcloud, Tidal, and YouTube Music, varying mainly on their audio selection, pricing model, and global availability.

In Figure 3.2, a "Mood" genre is visible (to the right), which hosts playlists of tracks that are, for instance, happy. This track categorization is achieved by Spotify's

audio analysis of its tracks' features, one of which is valence, a 0 to 1 measure of the musical positiveness conveyed by a track. The way this value is estimated is not described, with (url-SpotifyAPI) simply stating that "tracks with high valence sound more positive (e.g., happy, cheerful, euphoric), while tracks with low valence sound more negative (e.g., sad, depressed, angry)". As Music Goes By (a web application that will be reviewed on this document's subsection 3.2.3) used this measure to plot the emotions that a given track's cover can potentially elicit on those who listen to it, but Spotify's end-users cannot use this measure to, for example, find very highly valenced tracks.

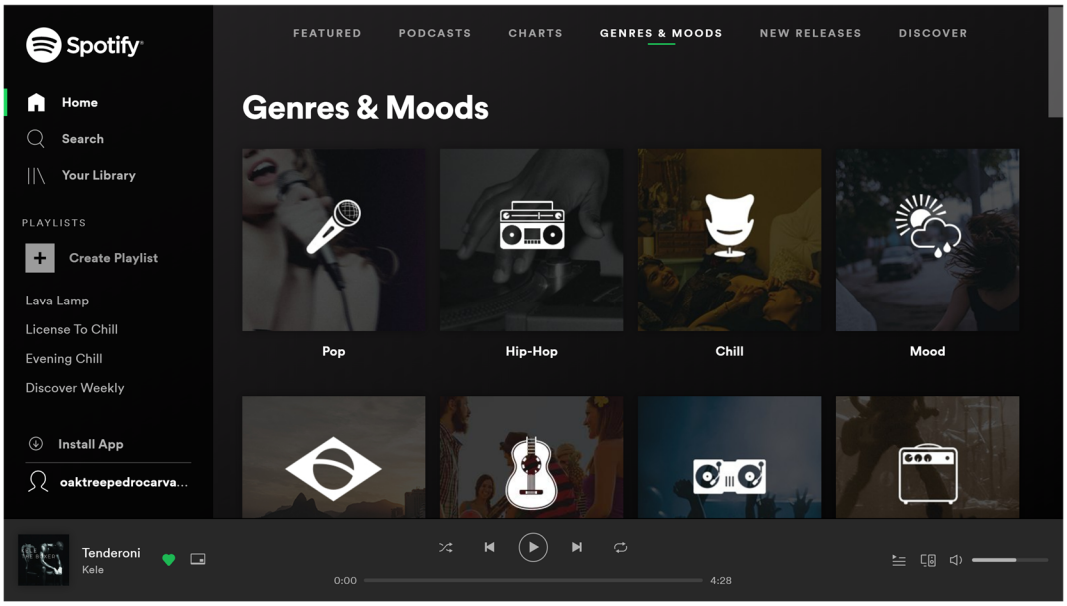

Figure 3.2 – Spotify's web player (url-Spotify).

3.1.3 Access to images

Flickr (url-Flickr) and Pinterest (url-Pinterest) are two image management and sharing applications that allow their users to search for, save, order, manage, and share images in pinboards and collections created by the user itself, or someone else.

Altough very similar, Flickr and Pinterest differ on their image searching mechanism – whereas Flickr (top of Figure 3.3) offers an assortment of filters that allow users to find images with a particular color, pattern, size, orientation, date, and license, Pinterest (bottom of Figure 3.3) only offers a varied selection of keywords to add to your image search (e.g., in searching for "Abstract" images, individuals may get keywords such as "Painting" or "Design" to add to their search). Not only that, but

Flickr also seems more oriented towards photography, whereas Pinterest has a mix of photography, infographics, illustrations, and pictorial quotes.

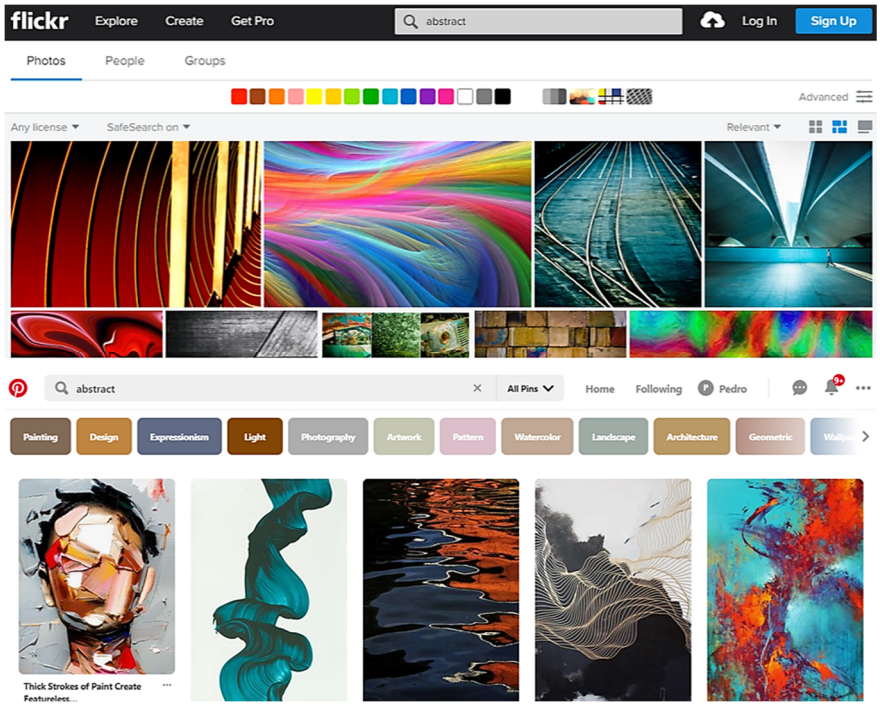

Figure 3.3 – Flickr (top; url-Flickr) and Pinterest (bottom; url-Pinterest) home pages.

3.1.4 Closing Remarks

All of the aforementioned platforms have tremendous entertainment value and allow individuals to take a much-needed break from all of real-life's demands. Despite this, none of them support the detection of emotions, nor do they actively pursue or incentivize individuals to be introspective and comment on how emotionally impactful some content might have been, and why – even if most (i.e., TED.com, Vimeo, YouTube, Flickr, and Pinterest) include comment or note-taking sections. Adding to this is the fact that these comment or note-taking sections are often public, which further dissuades individuals from opening up about their perceptions and reflections regarding their consumed contents. Spotify emotionally categorizes its tracks by automatically analyzing their conveyed musical positiveness (i.e., valence), instead of giving users the means to do so (e.g., self-assessment). That being said, the creation of playlists and other sorts of collections – aptly named by the emotional impact that its contents had on its consumers (e.g., a playlist called "Songs that made me happy") – is possible in most of these platforms, but the ability to add a brief description as to why each particular

entry was worthy of being saved (e.g., "This song reminded me of (…)") does not usually come along with this feature.

3.2 Previous Work

In this section, we go over some of the previous work that explores the emotional dimension of digital content, and was developed within LASIGE, as was the case with iFelt, MovieClouds, As Music Goes By, and Media4WellBeing.

3.2.1 iFelt

iFelt is an interactive web application (developed by Eva Oliveira with Adobe Flash) that allows its users to search, browse, access, visualize, and categorize movies and movie scenes according to their emotional properties (e.g., objective and subjective dominant emotion), and the users' emotional profiles, preferences, and mood (Chambel et al., 2011; Oliveira et al., 2011; Oliveira et al., 2013; Oliveira et al., 2015).

The iFelt system is composed of two components: 1) the "Emotional Movie Content Classification" component, and 2) the "Emotional Movie Access and Exploration" component.

1) Emotional Movie Content Classification: This component classifies and indexes movies and movie scenes based on two things – 1) the emotions these movies and movie scenes convey (i.e., the objective emotions; e.g., a particular movie scene showing a sad event), which are determined automatically by way of video content analysis, combined with audio and subtitles processing (Chambel et al., 2011; Oliveira et al., 2011; Oliveira et al., 2013); and 2) the emotions felt by users when watching them (i.e., the subjective emotions; e.g., sadness that results from relating to the sad event shown in that particular movie scene), which are determined a) automatically through the use of physiological sensors measuring users' heart rate, electrodermal activity, and respiration, or b) manually by having users select 2 to 5 emotions and their intensities from a wheel of 19 emotions (13 of which derive from Ekman's six basic emotions) that is inspired by the previously discussed Geneva Emotion Wheel (Oliveira et al., 2015) (Figure 3.4).

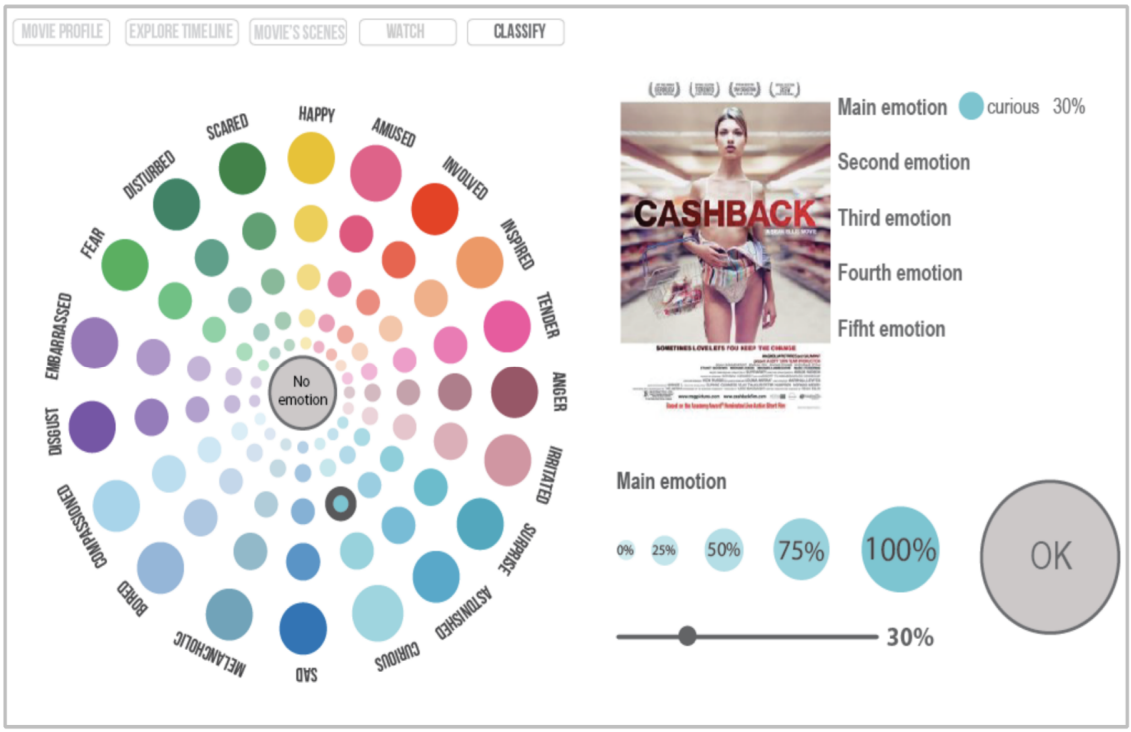

Figure 3.4 – iFelt's manual classification of a movie's subjective emotions (Oliveira et al., 2015).

Regarding the use of 19 emotional labels to classify movies and movie scenes, Oliveira et al. decided to 1) adopt Ekman's six basic emotions (namely, anger, disgust, fear, happiness, sadness, and surprise) for being the most well-known and agreed upon emotions, and 2) expand upon them by adding 13 additional labels (amused, involved, inspired, tender, curious, astonished, melancholic, compassioned, bored, scared, disturbed, embarrassed, and irritated) because they found that those six basic emotions were not enough to adequately describe the emotional complexity of movies and movie scenes (Oliveira et al., 2015). Ultimately, emotions are grouped as follows – anger is grouped with the irritated label; disgust is grouped with the embarrassed label; fear is grouped with the scared and disturbed labels; happiness is grouped with the involved, amused, inspired, and tender labels; sadness is grouped with the melancholic, compassioned, and bored labels; and surprise is grouped with the curious and astonished labels.

2) Emotional Movie Access and Exploration: This component explores ways to access and visualize movies and movie scenes based on their emotional properties, and the users' emotional profiles, preferences, and mood (Chambel et al., 2011; Oliveira et al., 2011; Oliveira et al., 2013; Oliveira et al., 2015).

Emotions are represented by colors, just like in Plutchik's model of emotion (Plutchik & Kellerman, 1980; Plutchik, 1983). Thus, anger, disgust, fear, happiness, sadness, and surprise are represented by the colors dark red, purple, green, yellow, dark blue, and light blue, respectively, whereas the remaining 13 emotions are represented by variations of the colors attributed to their associated basic emotion (e.g., bored, which is associated with the emotion of sadness, is represented by a lighter shade of sadness' dark blue) (bottom of Figure 3.5).

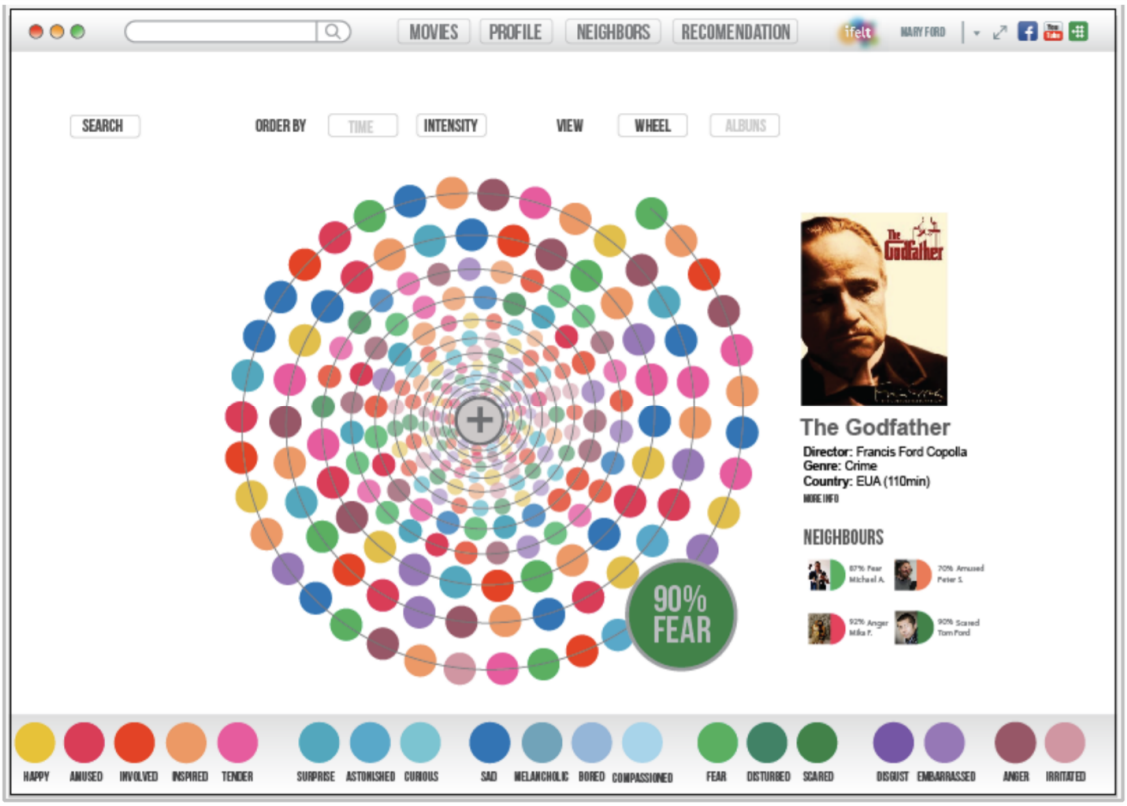

Figure 3.5 – iFelt's interface (home page), as of 2015 (Oliveira et al., 2015).

The menu at the top of Figure 3.5 allows users to navigate to 4 different spaces – the a) Movies, b) Profile, c) Neighbors, and d) Recommendation spaces.

a) Movies space: In the Movies space, users can search for and select movies by specifying one or more emotions (left of Figure 3.6), or by specifying other criteria (accessible through the "Other" prompt at the top left of Figure 3.6). In any case, movies can be displayed on a wheel (center of Figure 3.6) or as a list, which can then be sorted by time of release or intensity (top of Figure 3.6).

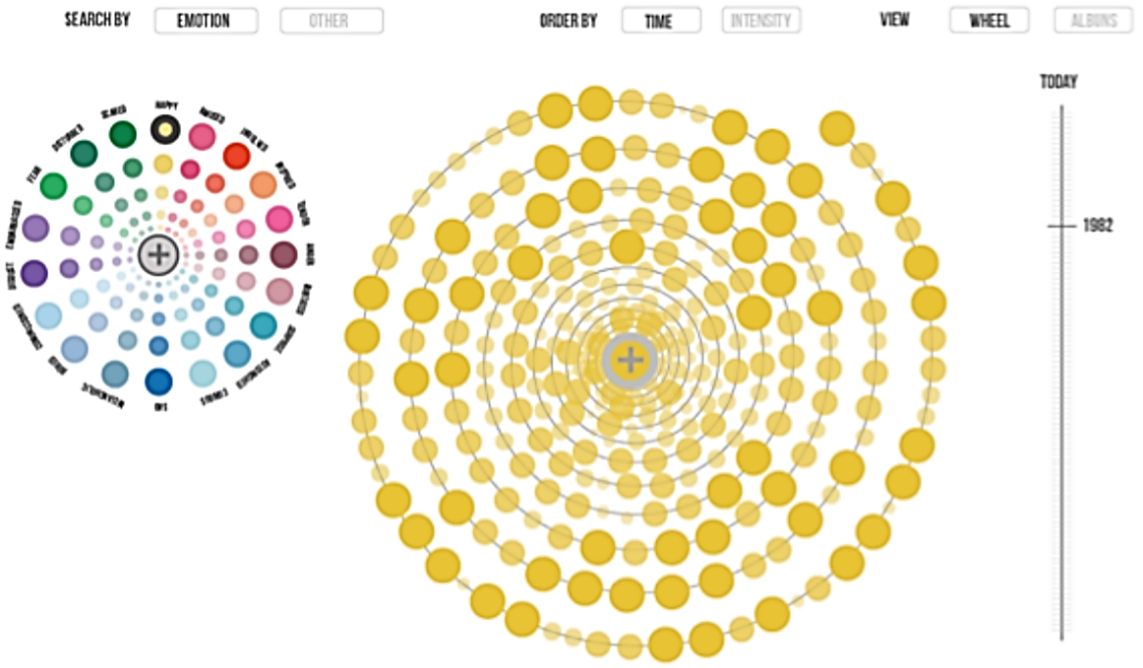

Figure 3.6 – iFelt's searching mechanism and its results: at the center, we can see what came out of searching for a movie by specifying the "Happy" emotion, selected on the left (Oliveira et al., 2015).

Once a movie is selected, users are redirected to that movie's profile (Figure 3.7). In a movie's profile, users can learn more about 1) the movie (e.g., said movie's director or genre, to the right of the movie's cover); 2) the emotions they felt throughout the movie (displayed on "Your Timeline", underneath the movie's cover and details) and in what percentages (just below the movie's details); 3) the emotions that the movie's director expected users to feel (displayed on a "Director" timeline), or that most users felt while watching it (displayed on the "Overall" timeline); 4) other users that have also watched that movie and felt similar emotions (also known as "Neighbors", which are displayed on the "Your Emotional Neighbors" section of the movie's profile); 5) the emotions that these neighbors felt throughout the movie (displayed in place of the "Overall" timeline by hovering over a particular neighbor); and 6) similar movies (bottom right of the page) (Oliveira et al., 2015).

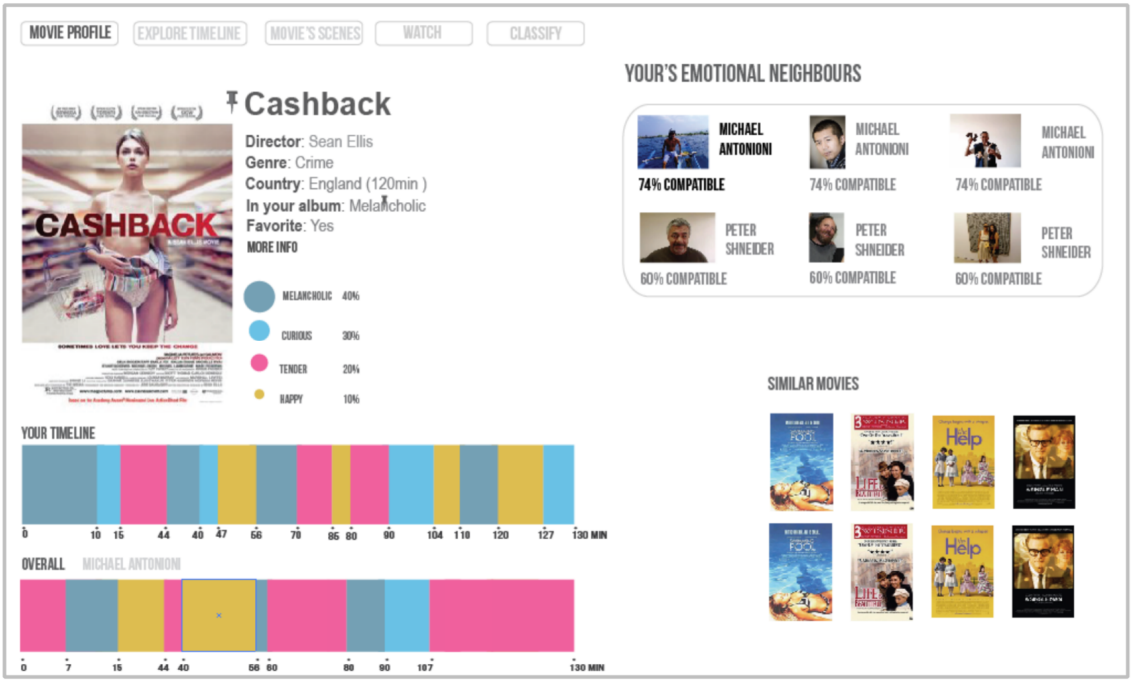

Figure 3.7 – iFelt's movie profile for "Cashback" (Oliveira et al., 2015).

From there, users can 1) access the "Explore Timeline" functionality, which gives them the possibility of reviewing the sequence of emotions they felt while watching the movie and its scenes, and then compare this sequence of emotions with those felt by other users, as well as watch the movie scenes that elicited a given emotion; 2) access the "Explore Movie Scenes" functionality, which gives users the chance of non-sequentially observe a movie's emotional scenes, which are represented by a circle whose color represents the emotion that was felt by them or other users, and whose size represents its dominance; 3) watch the selected movie; and 4) classify the selected movie (Oliveira et al., 2015).

b) Profile space: In the Profile space, users can check up on their personal information (e.g., name, profile photo), most dominantly felt emotions, percentage of felt emotions (e.g., 20% fear, 5% anger), last and all classified movies, and all classified scenes (Oliveira et al., 2011).

c) Neighbors space: In the Neighbors space, users can find and filter all of their neighbors (i.e., other users who have watched the same and/or emotionally similar movies as the user), and then access their movie lists (Oliveira et al., 2015).

d) Recommendations space: Finally, in the Recommendation space, users are recommended movies based on the emotions they select (e.g., "Recommend me something 'Happy'"), or based on a specific movie and its emotions (e.g., "Movie X elicits sadness, and so does Y and Z") (Oliveira et al., 2015).

3.2.2 MovieClouds

MovieClouds is an interactive web application (developed by Pedro Martins with HTML5, CSS3, JavaScript, and PHP) designed for users to search for, browse through, access, and visualize movies based on 5 of their features: 1) most commonly used words (e.g., "right") and 2) most commonly expressed emotions (e.g., "happy"), both extracted from the movies' subtitles through text processing techniques; 3) sound events (e.g., applause) and 4) soundtracks' conveyed mood (e.g., "tense"), detected and classified by way of audio processing techniques; and 5) elicited emotions (e.g., "surprise"), extracted from iFelt's categorization data (Martins et al., 2011).

MovieClouds is composed by two distinct views: 1) the Movies Space View, where users can search for and browse through MovieClouds' available movies; and 2) the Movie View, where users can watch the selected movie (Figure 3.8). In both views, tag clouds are cleverly employed to let users easily explore each movies' 5 features – namely, when certain words are said, emotions are expressed by movie characters and felt by the user (according to iFelt's data), and sounds are played and moods conveyed.

Figure 3.8 – MovieClouds' Movie View (Martins et al., 2011).

3.2.3 As Music Goes By

As Music Goes By is an interactive web application (developed by Acácio Moreira with AngularJS, D3, Node.js, and Express) that allows its users to search for, browse through, access, and consume music and movies from complementary perspectives that highlight how these two art forms relate (Moreira & Chambel, 2018). In a nutshell, users can 1) search for, compare, and listen to all the different versions of a given song in terms of artist (original vs. cover), date, genre (of which 17 were defined and mapped with a particular color), popularity, and emotions (of which there are 12, based on and represented in Russell's Circumplex model of emotion); and 2) search for and watch the movies and movie scenes where all these different versions of a given music appear.

As Music Goes By is composed of three distinct views: 1) the Tracks (Music) view, 2) the Artists view, and 3) the Movies view.

1) Tracks (Music) view: In Figure 3.9, we can see how, following a search for the song "Smoke Gets in Your Eyes" in the Tracks view, users are able to know who originally recorded the song (Gertrude Niesen, whose photo and name appears to the left), in what year that song was released (1933), how many covers of that song have been produced to date (133), and to what music genre that particular rendition of the song belongs to (Movie Scores and Musicals).

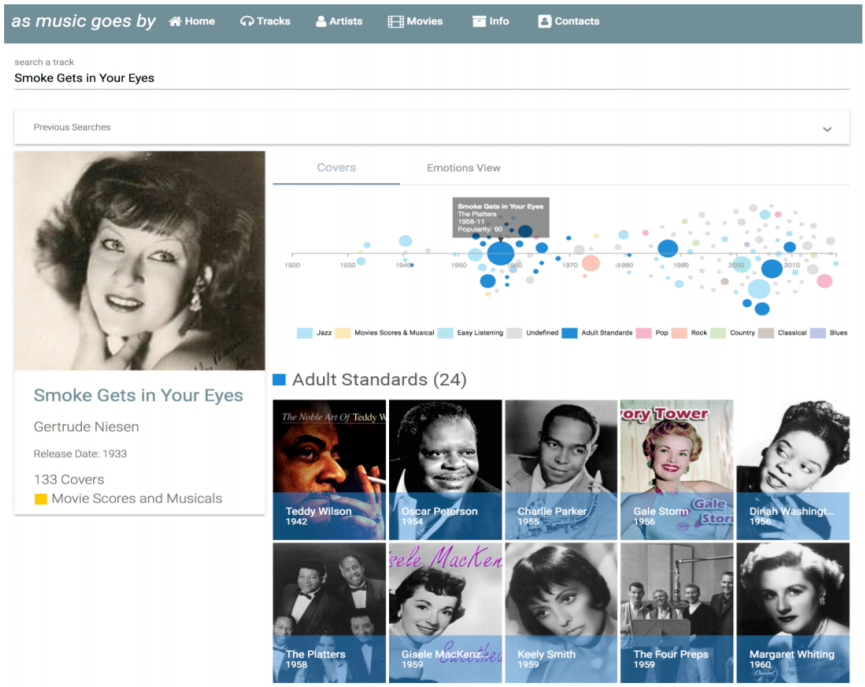

Figure 3.9 – As Music Goes By's results for "Smoke Gets in Your Eyes" (Moreira & Chambel, 2018).

Users are also given the chance to learn more about how many covers (represented by circles whose color and size speaks for those covers' music genre and popularity, respectively) of that song fall under a specific genre (24 Adult Standards covers), who recorded them (ordered by year), how popular they are (on the Covers timeline), and what emotions they evoke (determined by a song's valence (url-SpotifyAPI) and arousal audio features, which in turn determine its position on the emotional Circumplex of Figure 3.10).

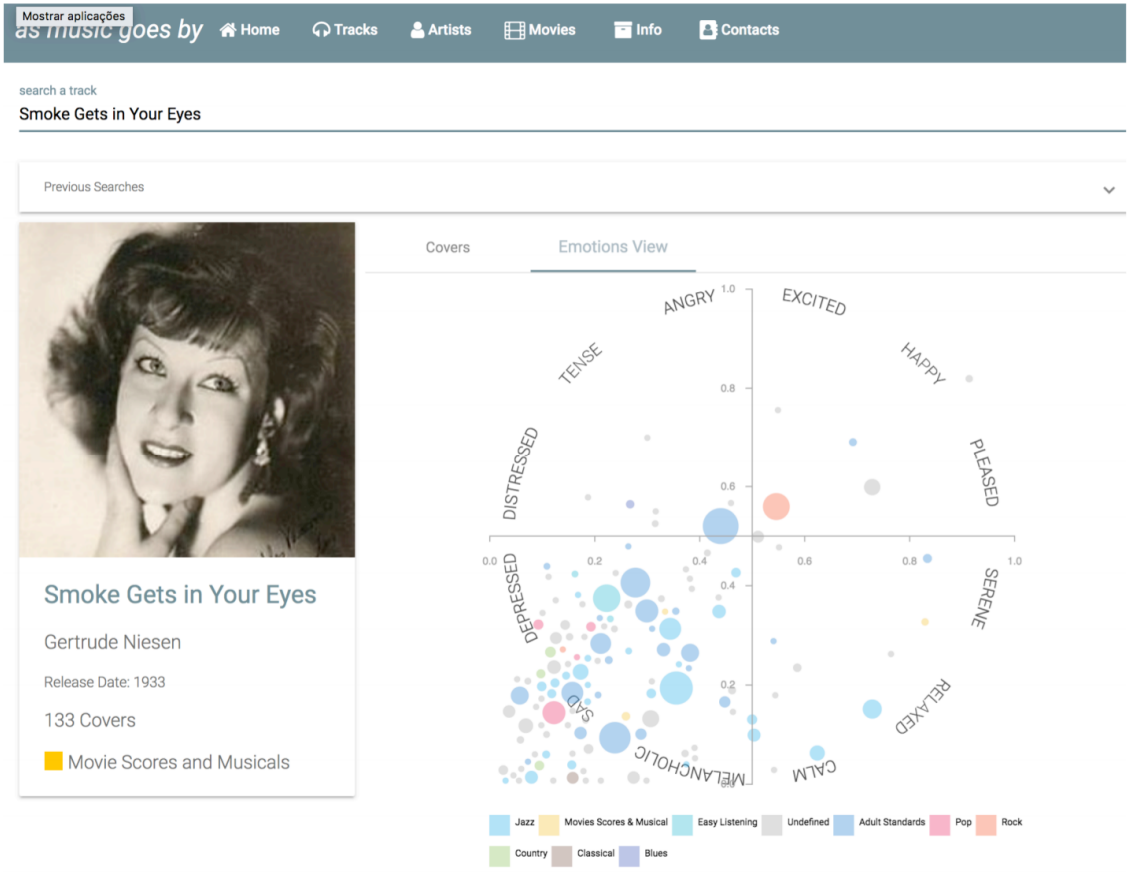

Figure 3.10 – The emotions elicited by all covers of "Smoke Gets in Your Eyes", determined by those covers' valence and arousal audio features (Moreira & Chambel, 2018).

When a song is selected (original or cover), a small window with that song's name, artist (photo, name, and year they recorded the song), genre, popularity, emotion (in the Circumplex to the right of that song's title, and just above its music video), and music video (extracted from YouTube) is displayed (Figure 3.11) – if two songs are selected, that very same window starts displaying both selected songs' aforementioned information (Figure 3.12), allowing users to compare song versions.

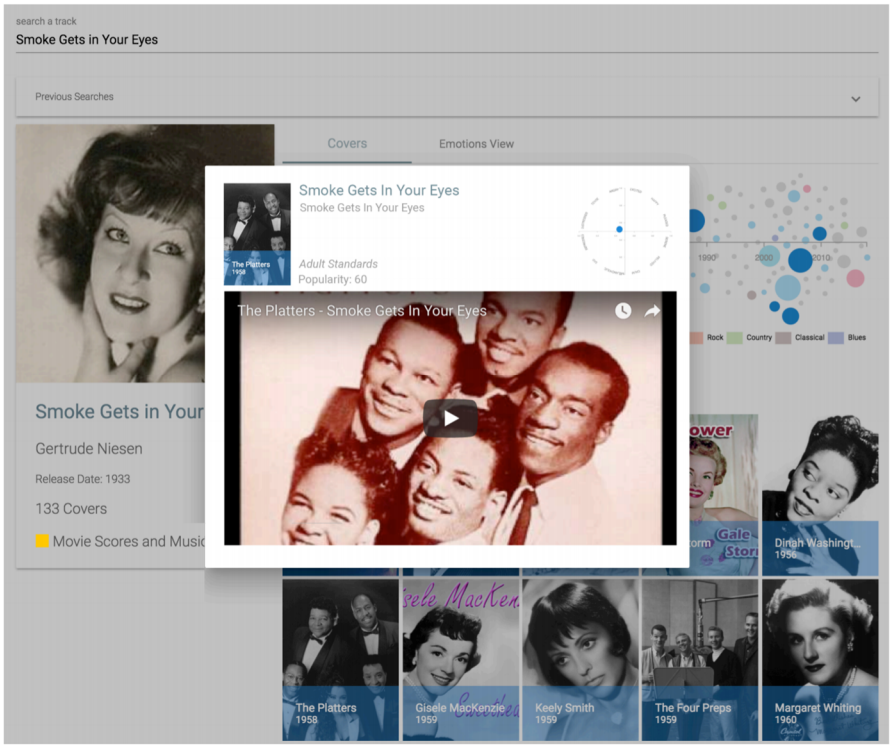

Figure 3.11 – User's selection of The Platters' rendition of "Smoke Gets in Your Eyes" (Moreira & Chambel, 2018).

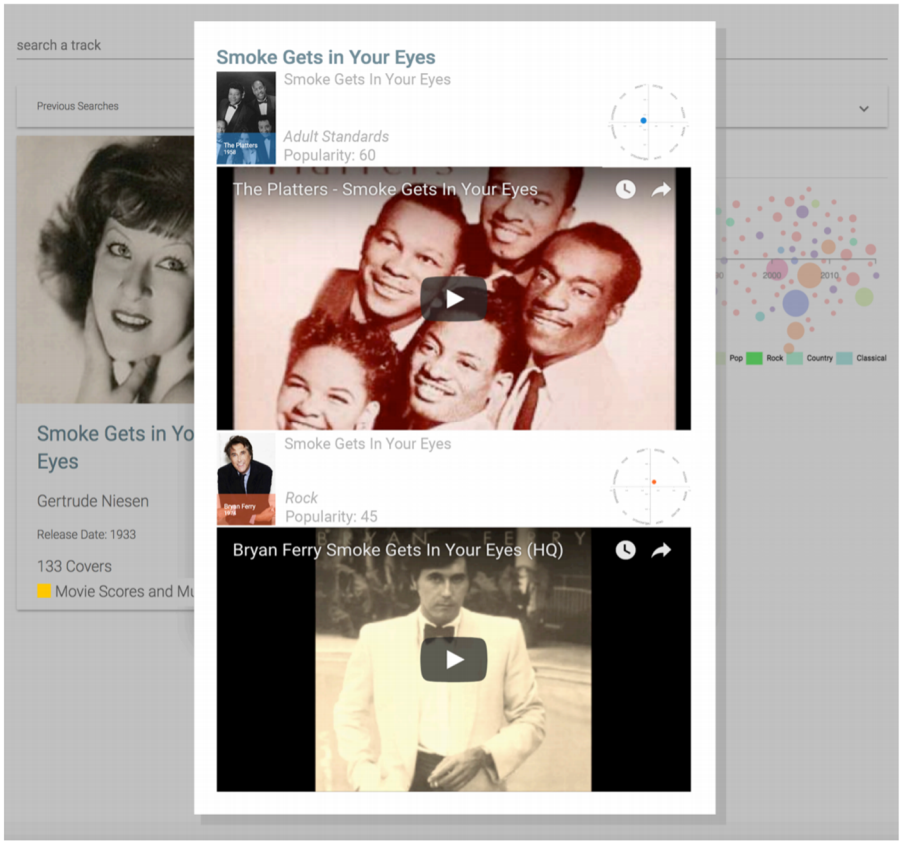

Figure 3.12 – User's comparison of two "Smoke Gets in Your Eyes" covers (Moreira & Chambel, 2018).

2) Artists view: In the Artists view, users can learn more about an artist (namely, their country of origin, date of birth, music genres, albums, tracks, and what emotions these tracks evoke).

3) Movies view: Finally, in the Movies view, users can search for and watch entire movies, whose movie poster, name, director, release date, and genre are presented alongside a synchronized timeline with the movie's tracks.

3.2.4 Media4WellBeing

Media4WellBeing is an interactive web application (developed by Carla Bernardino and then by Sílvia Martins, with HTML5, CSS3, JavaScript, jQuery, JSON, D3, Java, and PHP) that was created for the purpose of 1) giving users the ability to access and consume digital content (namely, videos, music, and images) based on its elicited emotions, 2) determining how digital content might help users reach certain states of concentration and meditation, and 3) determining how digital content might contribute to users' general wellbeing (Bernardino, 2018; Martins, 2018).

To suitably assess Media4WellBeing, we will survey: 1) its emotional model; 2) what happens during digital content consumption; and 3) what happens after digital content consumption.

1) Emotional model: Media4Wellbeing's emotional model (Figure 3.13a) is composed by 14 emotions. These emotions, which are mapped within Russell's Circumplex, were selected by virtue of 1) the findings of (Chambel et al., 2011) on what emotions are commonly associated with digital content consumption; and 2) the fact that they were simple enough to be automatically recognized by physiological sensors (namely, EEG, ECG, and EDA sensors). When it comes down to the color of each emotion (Figure 3.13b), (Bernardino, 2018) claims to follow Robert Plutchik's Wheel of Emotions.

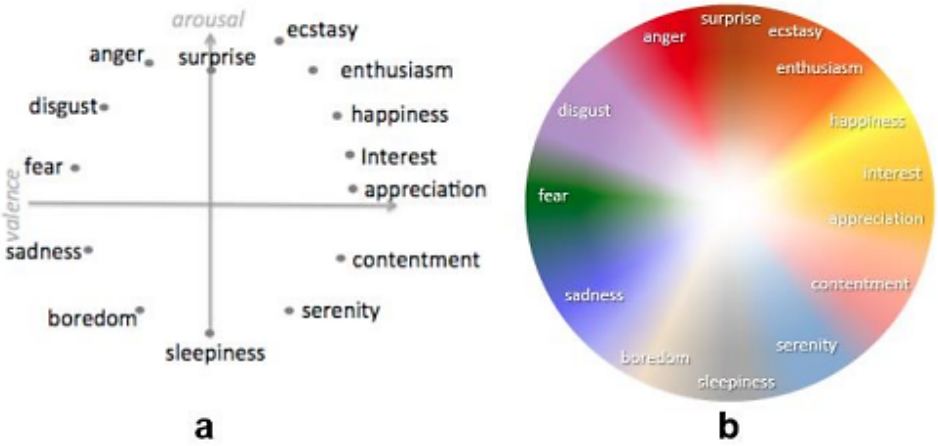

Figure 3.13 – Media4WellBeing's emotional model in a), and the colors of each of its emotions in b) (Bernardino, 2018).

2) During digital content consumption: Upon accessing Media4WellBeing, users are given the chance to search for, and select one of three kinds of digital content – videos, music, and images (Figure 3.14).

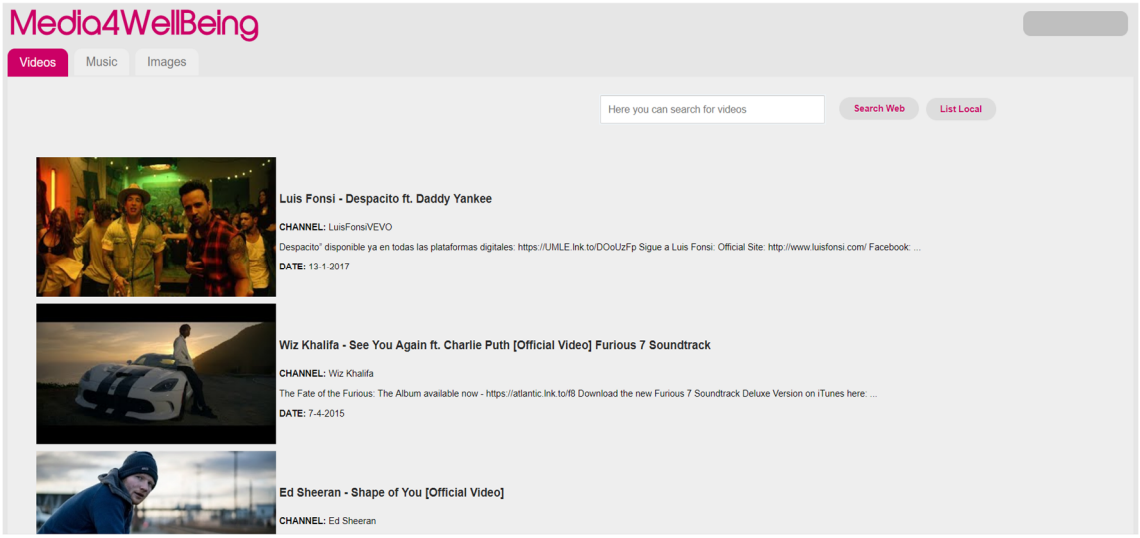

Figure 3.14 – Media4WellBeing's video selection screen (retrieved from the app).

Upon doing so, users are directed to a page where the selected content is played, and data concerning these users' felt emotions (Bernardino, 2018), concentration, meditation (Martins, 2018), and wellbeing levels (Bernardino, 2018; Martins, 2018) is captured by EEG (Bernardino, 2018; Martins, 2018), ECG, and EDA sensors[3] (Bernardino, 2018) connected to them. This data can be displayed to users in real-time (allowing them to acknowledge that they are feeling certain emotions, or reaching certain states of concentration, meditation, and wellbeing throughout their digital

[3] According to (Bernardino, 2018) and (Martins, 2018), a MUSE headband is used for EEG, and a BITalino sensor kit is used for ECG and EDA.

content consumption), or hidden and replayed once the selected content has finished playing (should users yearn for a more distraction-free experience).

Users' emotional data can be visualized through 3 complementary views – the "emoPaint", "emoClouds", and "emoChart" views. In the "emoPaint" view, a painting of users' emotional evolution is presented (Figure 3.15a). In the "emoClouds" view, a tag cloud describing users' emotional experience is presented. Each tag in this tag cloud represents a felt emotion. A tag's color and size is determined by the emotion it represents and its dominance (Figure 3.15b). Finally, in the "emoChart" view, a bar chart with the percentage of time that a user has felt a particular emotion is shown (Figure 3.15c). As hinted above, all these views' generated results can be replayed, which is done in synch with the consumed content and with the assistance of a timeline that allows users to access the moments when a given emotion was experienced and thus reflected in these views.

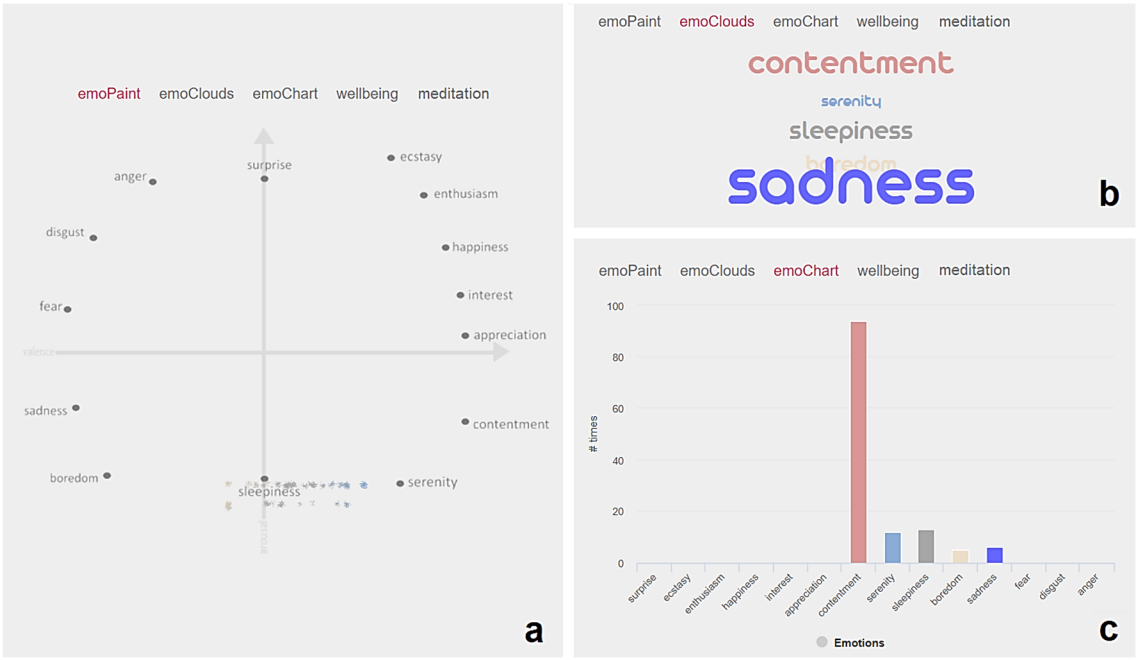

Figure 3.15 – Media4WellBeing's emotional data views: a) "emoPaint"; b) "emoClouds"; and c) "emoChart" (Bernardino, 2018).

As for users' concentration (i.e., attention), meditation, and wellbeing levels, they may be visualized through 2 distinct views – the "wellbeing" view, and the "meditation" view. In the "wellbeing" view, users are presented with a simple graph detailing how their concentration, meditation, and wellbeing levels changed throughout the consumption of a given piece of digital content (Figure 3.16) (Bernardino et al., 2016).

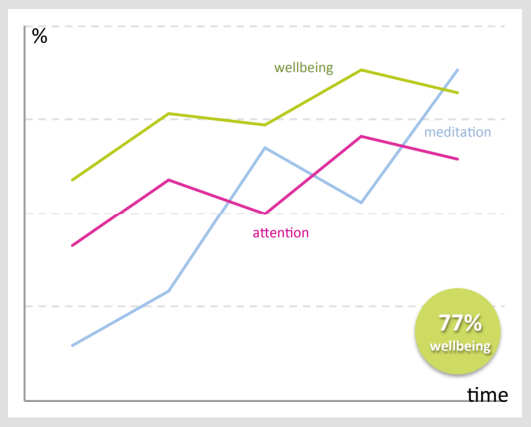

Figure 3.16 – Media4WellBeing's "wellbeing" view (Bernardino et al., 2016).

In the "meditation" view, users are presented with 3 subviews detailing the evolution of their gamma, beta, alpha, theta, and delta brainwaves (whose significance is minutely explained in (Martins, 2018)) (Figure 3.17a), and their concentration and meditation levels (Figures 3.17b and 3.17c, respectively).

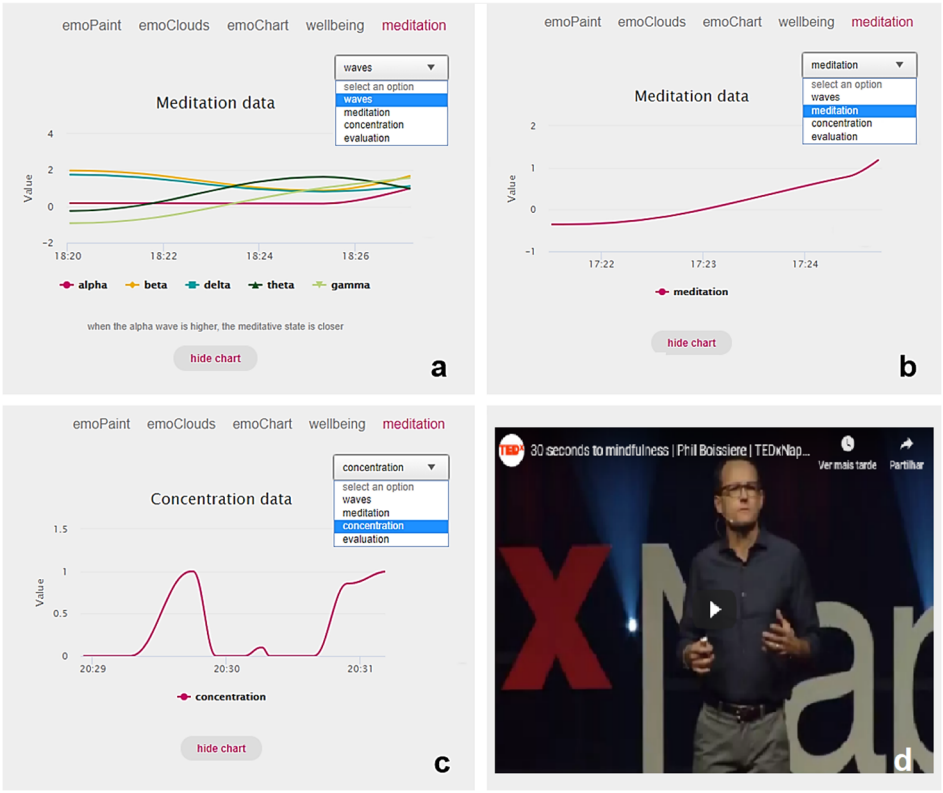

Figure 3.17 – Media4WellBeing's "meditation" view and its a) "waves", b) "meditation", and c) "concentration" subviews, whose results came from consuming the video in d) (Martins, 2018).

All this data, and all these views allow users to understand what kind of digital content helps them reach certain emotional and cognitive states, which is Media4WellBeing's greatest asset.

3) After digital content consumption: After some digital content has been consumed, emotional data is automatically processed to 1) classify digital content by the user's predominantly felt emotion (according to Media4WellBeing's physiological sensors) (Figure 3.18); and to 2) form some statistics about the user – namely, what emotions have been experienced (Figure 3.19).

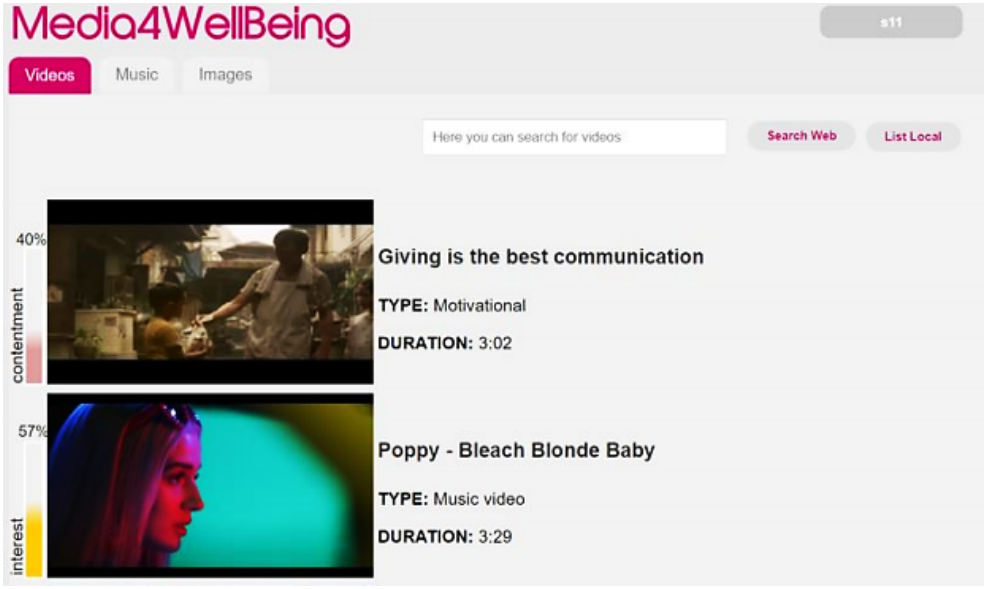

Figure 3.18 – Media4WellBeing's video selection screen, with its contents classified by the user's predominantly felt emotion (Bernardino, 2018).

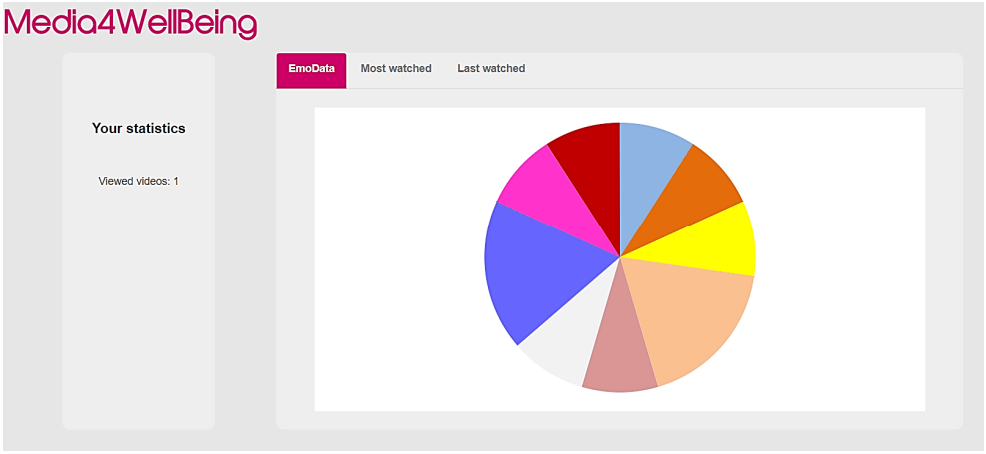

Figure 3.19 – Media4WellBeing's records of what emotions were experienced by a particular user (retrieved from the app).

In terms of concentration and meditation levels, users are allowed to supplement the data that was collected by 1) opening the "meditation" view of the content's reproduction page, 2) selecting its "evaluation" subview (Figure 3.20a), and 3) drawing their own line graph in a shape that they believe to best describe their concentration or meditation levels throughout some digital content's consumption (although the interface

could be more explicit on what line the user is about to draw – the one about concentration levels or meditation levels).

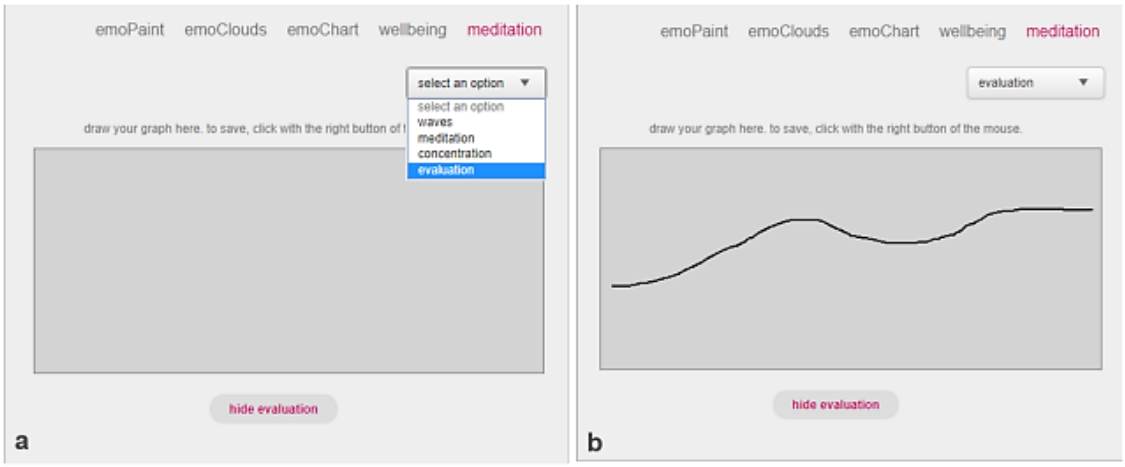

Figure 3.20 – Media4WellBeing's process of supplementing the determined concentration and meditation levels by a) opening the drawing area; and b) drawing one's perceived concentration and/or meditation levels (Martins, 2018).

These drawings and their associated content can then be added to the user's journal, along with some tags, for greater journal organization (Figure 3.21).

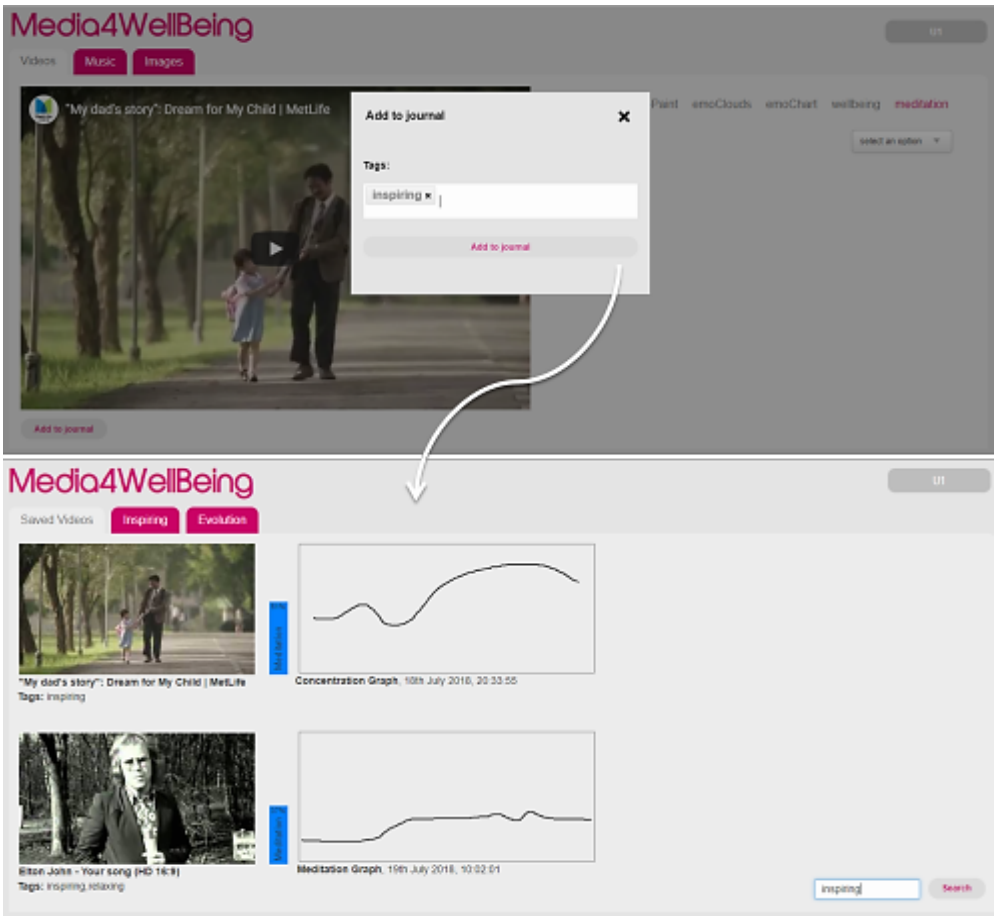

Figure 3.21 – Media4WellBeing's process of adding a video and a concentration drawing to one's journal (Martins, 2018).

From their journal, users can access inspiring and motivational quotes, and study 3 graphs that show how their meditation and concentration levels have evolved since they have first started using Media4WellBeing.

Table 3.1 – Summary of all reviewed previous work.

Application	References	Development technologies	Physiological sensors	Models of emotion
iFelt	Chambel et al., 2011 Oliveira et al., 2011 Oliveira et al., 2013 Oliveira et al., 2015	Flash	ECG, EDA, RESP	Ekman, Plutchik, GEW
MovieClouds	Martins et al., 2011	HTML5, CSS3, JavaScript, PHP	ECG, EDA, RESP	Ekman, Plutchik
As Music Goes By	Moreira & Chambel, 2018	AngularJS, D3, Node.js, Express	-	Circumplex
Media4WellBeing	Bernardino, 2018 Sílvia Martins, 2018	HTML5, CSS3, JavaScript, jQuery, JSON, D3, Java, PHP	EEG, ECG, EDA	Ekman, Circumplex, Plutchik

3.2.5 Closing Remarks

All of the previous work explores – to a certain extent – the emotional dimension of the digital content it provides: in iFelt, it is possible to access, visualize, and categorize movies and their scenes according to one's felt emotions (manually or automatically determined) (Chambel et al., 2011; Oliveira et al., 2011; Oliveira et al., 2013; Oliveira et al., 2015); in MovieClouds, it is possible to access, explore, and visualize movies based on a) the words, emotions, sounds, and moods conveyed by its subtitles and audio, and b) the emotions that were felt by users, according to iFelt's categorization data (Martins et al., 2011); in As Music Goes By, it is possible to access, explore, and consume music and movies based on several music features, among which its evoked emotions stand out (Moreira & Chambel, 2018); and in Media4WellBeing, it is possible to access and consume videos, music, and images based on their elicited emotions and induced states of concentration, meditation, and wellbeing (Bernardino, 2018; Martins, 2018).

Aside from 1) iFelt's process of manually categorizing a movie and its scenes according to one's felt emotions (Oliveira et al., 2015), and 2) Media4WellBeing's recent efforts in allowing its users to draw their perceived concentration and meditation levels (Martins, 2018), none of the previous work allows its users to state if they agree

with the automatically detected emotions, nor elaborate on why they have experienced those and/or other emotions. Also aside from Media4WellBeing's recent introduction of a journal where digital content can be tagged and saved (Martins, 2018), no prior work allows its users to store digital content that made them experience the identified emotions, and that positively contributed to their psychological wellbeing. This is something that we intend to improve upon with our work, described in the following chapter.

3.3 Applications that Relate to the Happiness Jar

In this section, we go over some web and mobile applications that relate to the Happiness Jar in that they allow their users to register and later recall how they felt about things of significance.

3.3.1 The Gratitude Jar

The Gratitude Jar (url-TheGratitudeJar) is a web application (developed by Basch Solutions, using a mix of HTML, CSS, and jQuery) where individuals can publicly share the things they, themselves, feel grateful for, and read about the things that other individuals feel grateful for.

Upon visiting and scrolling down, individuals are shown the latest "Gratitudes", grey rectangles with text describing what a particular person feels grateful for (Figure 3.22). These "Gratitudes" can easily be filtered by location (giving users the ability to learn what individuals from other places and cultures feel grateful for), or by tag (giving users the ability to find "Gratitudes" about specific things, and perhaps giving them inspiration to write a "Gratitude" about something).

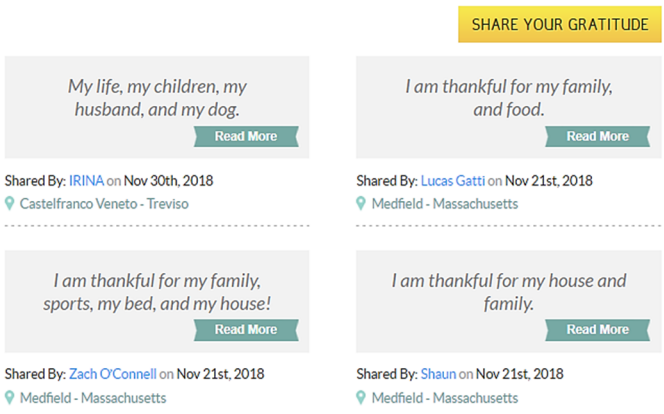

Figure 3.22 – A sample of "Gratitudes" created by the users of The Gratitude Jar web application (url-TheGratitudeJar).

They can just as easily be created by clicking on the "Share Your Gratitude" prompts scattered throughout the application. Upon doing so, a window pops up, asking the user to provide a name, some comma-separated tags (optionally), location, things to be grateful for, and an image (optionally) (Figure 3.23).

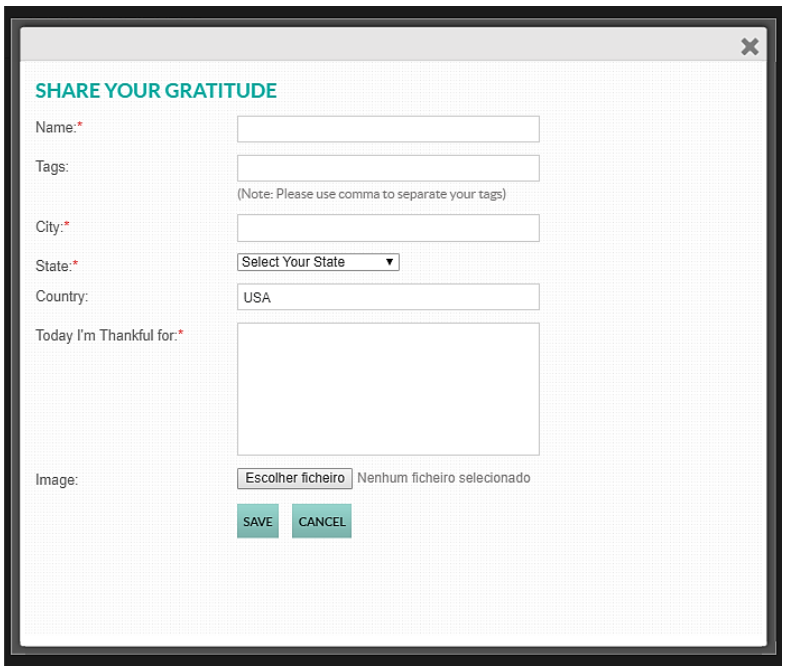

Figure 3.23 – The Gratitude Jar's process of creating a "Gratitude" (url-TheGratitudeJar).

The resulting "Gratitude" is then presented on the home page and in the previously described and shown shape (Figure 3.22).

3.3.2 The Happiness Jar

The Happiness Jar (url-TheHappinessJarApp) is a mobile application (developed by Edgars Zvirgzds, exclusively for iOS devices) where individuals can store, categorize, sort through, and later recall moments that were meaningful to them. These moments, represented by small colored marbles which are kept within a transparent glass jar (Figure 3.24a), can be related to 1) an enjoyable activity (green), 2) an interpersonal relationship (magenta), 3) understanding the meaning of something (purple), 4) the experience of a positive emotion (yellow), 5) achieving something (blue), or 6) anything else that does not fit the previous 5 categories (orange) (url-TheHappinessJarWebsite).

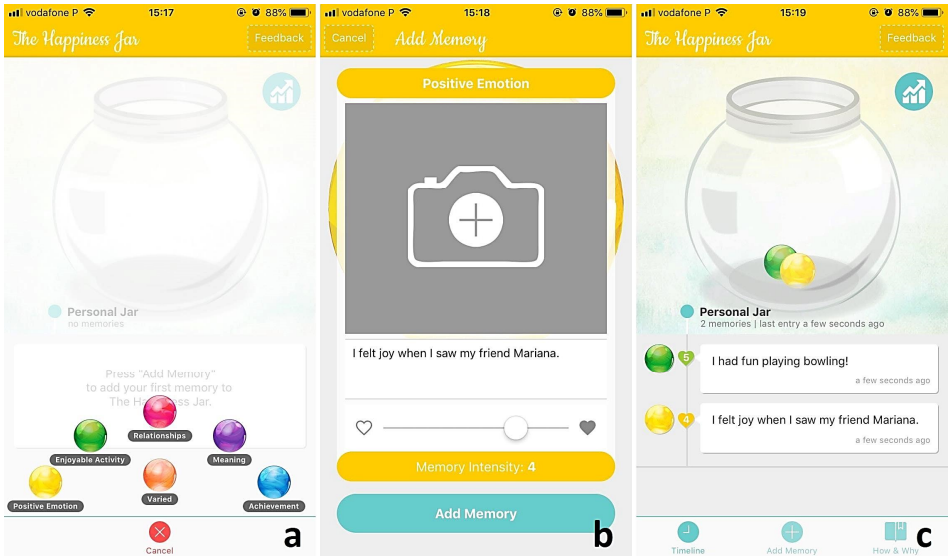

Figure 3.24 – The Happiness Jar app: a) the "marbles" of The Happiness Jar; b) creating a new entry; c) The Happiness Jar with 2 entries (retrieved from the app).

Upon creating an entry, users are asked to 1) associate a picture (optional), 2) describe the moment that led to the creation of the entry, and 3) indicate how intense that moment was (Figure 3.24b). A timeline is then built underneath the jar (which can be scrolled through, and used to access each individual jar entry, represented by its colored marble, and accompanied by its intensity and description), as is a set of statistics which can be accessed by clicking on the blue icon on the top-right corner of the screen (Figure 3.24c).

3.3.3 HappiJar

The HappiJar (url-HappiJarApp) is a mobile application (designed and developed by Glen Cooper, entirely for iOS devices) that is similar to The Happiness Jar app, in the sense that it allows its users to store and later recall moments that were meaningful to them. Some details set it apart, though, like 1) the use of customizable sewing buttons – instead of colored marbles – to represent the jar's entries, 2) the ability to annex audio to jar entries, 3) the ability to share a jar with different people, and 4) the use of haptic features like shaking one's device (i.e., the jar) to extract and review a randomly selected entry.

When users first enter the HappiJar app, they are shown a static image of a HappiJar that, confusingly, already contains 7 HappiButtons (the name of each sewing button that represents a HappiJar entry), even though the user has yet to create one (Figure 3.25a).

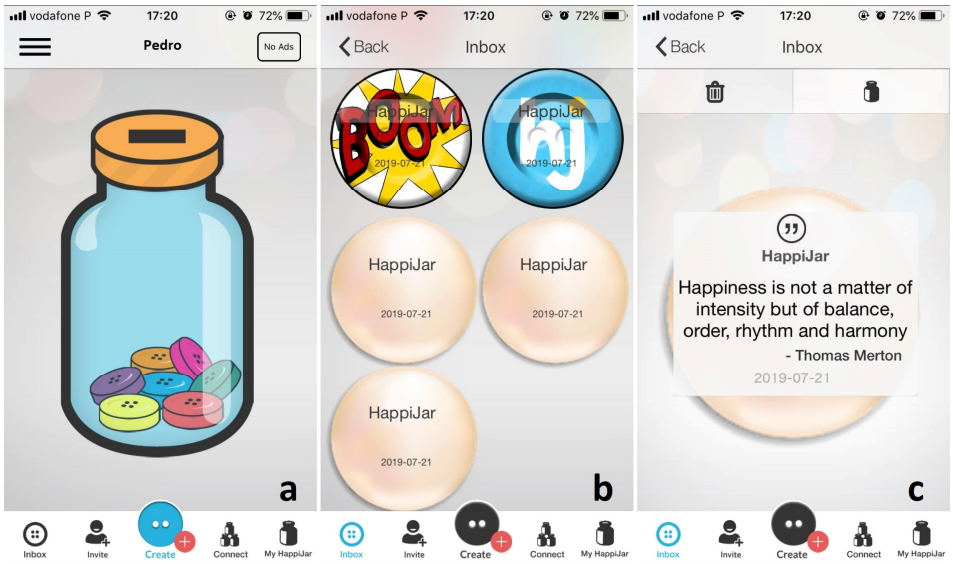

Figure 3.25 – HappiJar app: a) The HappiJar itself; b) its inbox; and c) opening a HappiButton that was shared with the user (retrieved from the app).

From there, users can go to the Inbox section, where they may find, open, and save HappiButtons sent by other users (Figures 3.25b and 3.25c). On the Invite and Connect screens, users can respectively place and accept requests to share a HappiJar. Finally, on the Create and My HappiJar sections, users can respectively create and review HappiButtons: to create HappiButtons, users select (and optionally edit) a design style (Figure 3.26a), and associate text, images, and/or audio (Figure 3.26b); to review HappiButtons (created or received), users can simply select them (Figure 3.26c).

Figure 3.26 – HappiJar app: a) Designs that can be applied to HappiButtons, upon their creation; b) A newly created HappiButton; c) A list of all created and saved HappiButtons (retrieved from the app).

That being said, the image that represents the HappiJar (Figure 3.25a) does not reflect the amount of HappiButtons collected by the user, nor their designs (e.g., color). Interestingly, if users shake their devices (i.e., their HappiJar), that image tilts, and one of the collected entries is shown, much in the style of Figure 3.26b. This is a feature that is sponsored by the accelerometer present in the mobile devices of HappiJar's users.

3.3.4 Cove

Cove (url-CoveWebsite) is a mobile app (developed by Humane Engineering, and only available for iOS smartphones and tablets) that allows its users to express how they feel (their emotions and moods) by making small loops of music (called "coves"), and storing them in a personal journal.

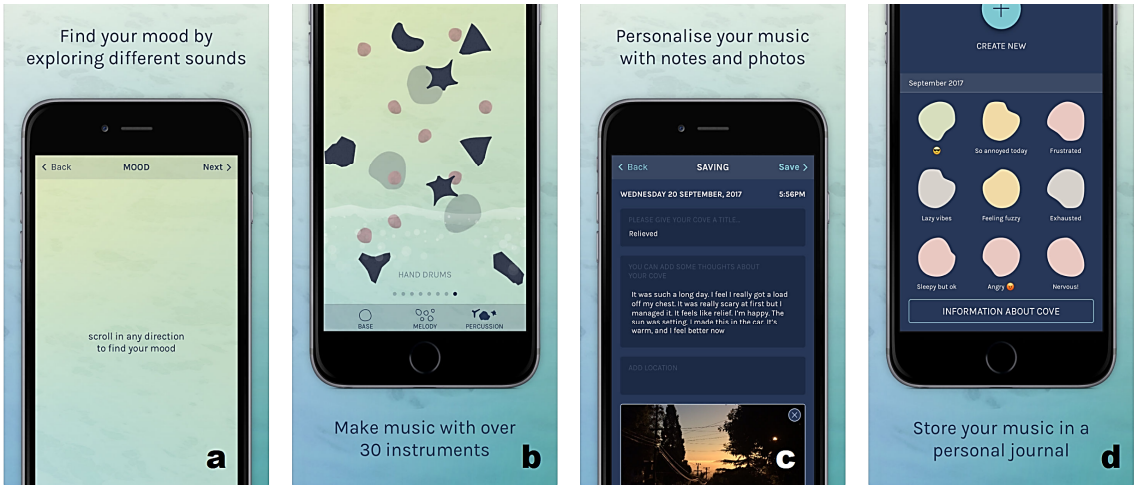

Figure 3.27 – Cove app: a) background theme and tune selection; b) dropping stones to create a melody; c) adding notes to a "cove"; and d) user's created "coves" (url-CoveApp).

When creating a new music loop (i.e., a new entry in their personal journal), users are first asked about how they feel at the time of that music loop's creation. They may describe how they feel by selecting one or more of the provided tags. They are then asked to select the background theme and tune that best reflects their current mood (Figure 3.27a). After doing so, users are shown a watery scene (Figure 3.27b) to which they can drop big stones (representing an instrument's chords), small stones (representing an instrument's single notes), or oddly shaped stones (representing a percussion instrument or style). Once they have finished their "cove", users can save it in their journal (Figure 3.27d) by optionally 1) giving it a title, 2) associating their thoughts, a location, and an image to it, and 3) selecting one or more of the aforementioned tags to describe how they felt after making it (Figure 3.27c).

3.4 Discussion

In this chapter, we went over some of the platforms that currently grant individuals access to digital content (namely, video, audio, and images). In doing so, it soon became clear that these platforms (e.g., YouTube, Spotify, Pinterest) do not support the detection of emotions, nor do they actively pursue or incentivize individuals to be introspective and comment on how emotionally impactful some content might have been, and why. This pointed us in the direction of two kinds of applications – those that explore the emotional dimension of digital content (iFelt, MovieClouds, As Music Goes By, and Media4WellBeing); and those that relate to the Happiness Jar, in the sense that they make it possible for individuals to chronicle, and later reminisce upon things of significance, and their associated emotions (The Gratitude Jar, The Happiness Jar, HappiJar, and Cove).

With the first kind of applications (i.e., those that explore the emotional dimension of digital content), we came to understand that individuals do experience emotions upon consuming digital content, and that these emotions can be automatically detected and used to search for, browse through, access, and even categorize digital content; on the other hand, we noticed that 1) users are never asked if they agree with the emotions that were automatically recognized through their employed physiological sensors (which might, for example, result in some content being erroneously categorized as having made the user angry, frustrating the user in the process); and that 2) users are never asked to elaborate on why they have experienced certain emotions, leaving them to wonder, in the future, if an emotion was experienced by virtue of the digital content itself (e.g., "I experienced happiness because the movie had a happy ending"), or thanks to some evoked memory (e.g., "I experienced happiness because the movie reminded me of (…)").

As for the second kind of applications (i.e., those that relate to the Happiness Jar), we realized that there are some apps that allow individuals to record and later recount meaningful things and their associated emotions, but most of them do not focus on – or ultimately allow – the saving of impactful digital content other than images (with none of them allowing video, and only the HappiJar and Cove apps allowing audio), nor do they use digital content as a tool that individuals can employ to recall things that

positively contributed to their wellbeing (e.g., “This video reminded me of this Coldplay concert I went to 10 years ago, which I loved”).

Overall, it is the strengths and weaknesses of all presented applications that inspire our work, the emoJar system, whose design rationale and implementation will be presented in the chapters to come.

Chapter 4

EmoJar System's Design Rationale

This chapter describes the design choices made for the emoJar system, which we propose as an extension to Media4WellBeing following our research on 1) how digital content, its consumption, and the experience of emotions might relate and contribute to individuals' psychological wellbeing, and 2) all the work, web, and mobile applications presented in the previous chapter.

The emoJar system is a web-based system that allows its users to collect, search for, browse through, access, recall, and reexperience memorable digital content that not only made them experience a number of emotions, but ultimately might have contributed to their psychological wellbeing. It was designed based on the previously described Happiness Jar concept, and it works by essentially presenting users with a jar – the "emoJar" – in which memorable digital content, its associated emotional data (gathered through the optional use of Media4WellBeing's physiological sensors, and/or via users' self-assessment), and the reasons as to why said digital content was memorable and emotionally impactful can be stored through a straightforward process of selecting, consuming, saving, and commenting said digital content.

What follows is a more comprehensive explanation of each perspective and feature of the emoJar system, and the rationale that supported the design of each.

4.1 Functional Requirements

Denoted by "FR", the following functional requirements describe what the emoJar system should allow its users to do (and thus its functionalities). These resulted from our 1) study of the topics covered in Chapter 2, 2) analysis of the strengths and

weaknesses of all the work, web, and mobile applications presented in Chapter 3, and 3) user-independent brainstorming and sketching sessions.

- **FR1**: Users should be able to store videos, audio, images, and quotes in their emoJar;
- **FR2**: Users should be able to get real-time feedback of their experienced emotions throughout their selected content's consumption (determined by Media4WellBeing's emotion recognition system, which employs the use of physiological sensors);
- **FR3**: Users should be able to provide their self-assessment about any consumed content;
  - **FR3.1**: Users should be able to register how much they agree with Media4WellBeing's emotion recognition results;
  - **FR3.2**: Users should be able to draw and elaborate on the emotions they believe to have felt;
  - **FR3.3**: Users should be able to elaborate on why the consumed content was memorable;
- **FR4**: Users should be able to quickly determine the type of content that is associated to an emoJar entry;
- **FR5**: Users should be able to preview the contents of any emoJar entry without having the need to open it (e.g., know what content an entry is about and if it includes sensor and/or self-assessment data);
- **FR6**: Users should be able to open and review any emoJar entry (namely, its associated content, sensor data, and self-assessment data);
- **FR7**: Users should be able to filter through the emoJar's entries based on their characteristics (e.g., the emotion that was predominantly felt by the user at the time of the associated content's consumption, or the date it was created), so as to find whatever entries they are looking for;
- **FR8**: Users should be able to extract a random entry from their emoJar by clicking on a button or shaking their mobile devices;
- **FR9**: Users should be able to get an overview of their emoJar system's use.

4.2 Non-functional Requirements

Denoted by "NFR", the following non-functional requirements describe how the emoJar system should perform (e.g., it should load in less than X seconds).

- **NFR1**: The emoJar system should be available in, and accessible from computers and mobile devices (i.e., tablets and smartphones);
- **NFR2**: The emoJar system's interface should be responsive (i.e., adapt) to most screen and window sizes;
- **NFR3**: Each page and perspective of the emoJar system should load quickly (in less than 2 seconds);
- **NFR4**: The emoJar system's interface should be consistent, straightforward, and easy to use;
- **NFR5**: The emoJar system should be easy to use and should provide a good user experience.

4.3 Design Process

To get a better sense of how the emoJar system would work and look like, a low-fidelity, visual representation of it was designed (Figure 4.1).

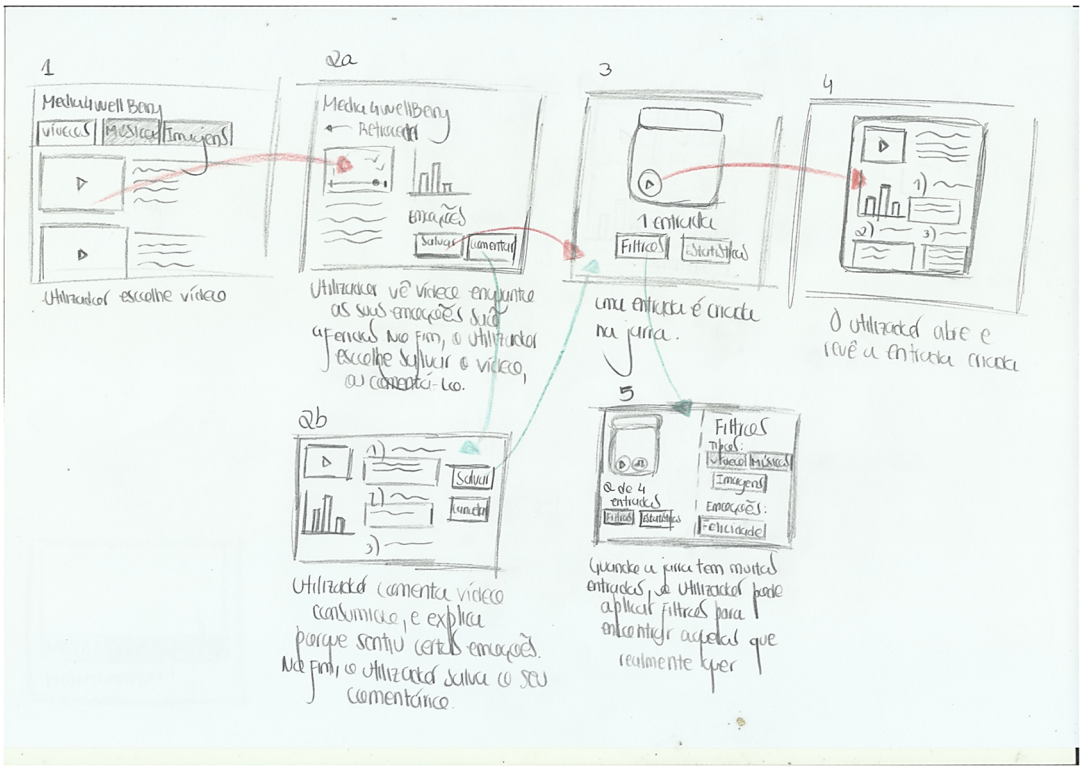

Figure 4.1 – An early sketch of the emoJar system and its interface (steps 1 through 5 explained next).

The idea it tries to convey is that individuals select some digital content (square 1) and have their emotions determined by way of sensors while consuming it (square 2a). Then, if they consider the content worthy of being saved and/or commented upon (square 2b), an entry for it – with all associated sensor and/or self-assessment data – is created and stored within the user's emoJar (square 3), which can be reviewed whenever the user so desires (square 4). As their emoJar begins to fill up, users can filter through its entries (square 5) so as to find whichever entry they are looking for (e.g., an entry about a video that made them experience happiness).

This simple outline of the system's flow and presentation was continually iterated and incremented upon – with this "iterate and increment" approach being employed throughout the entire development process of the emoJar system – and eventually gave way to a more elaborated, medium-fidelity mock-up that, however incomplete, more closely resembled the interface's final look and layout (Figures 4.2 and 4.3). Since the emoJar system was proposed as an extension to Media4WellBeing, an effort to be faithful to this application's original layout was made when making these mock-ups. Nevertheless, some changes were introduced, whose purpose will be discussed in the following section.

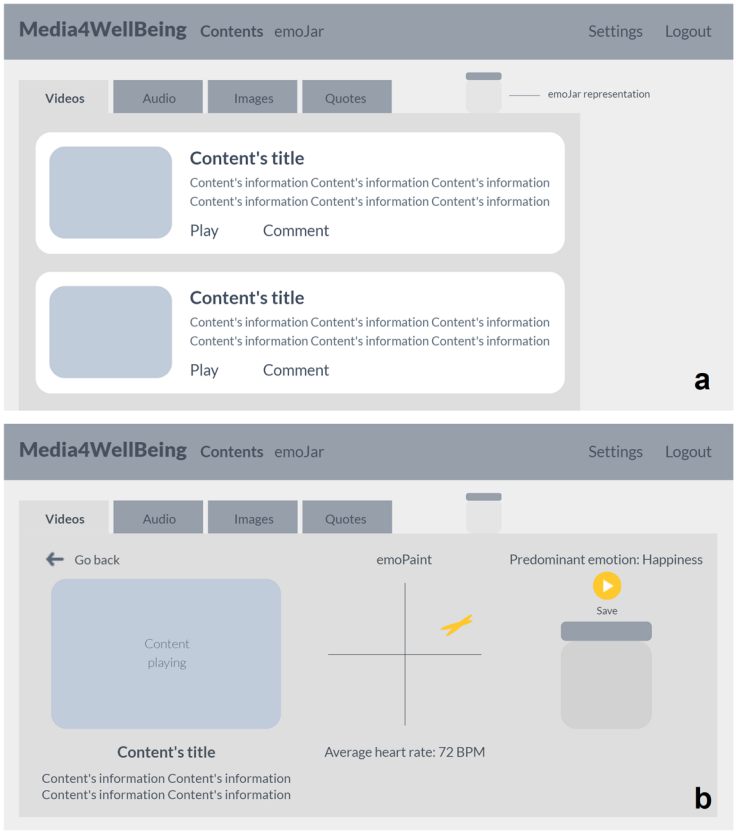

Figure 4.2 – EmoJar system's mock-up of a) the content selection page, and b) the content reproduction page.

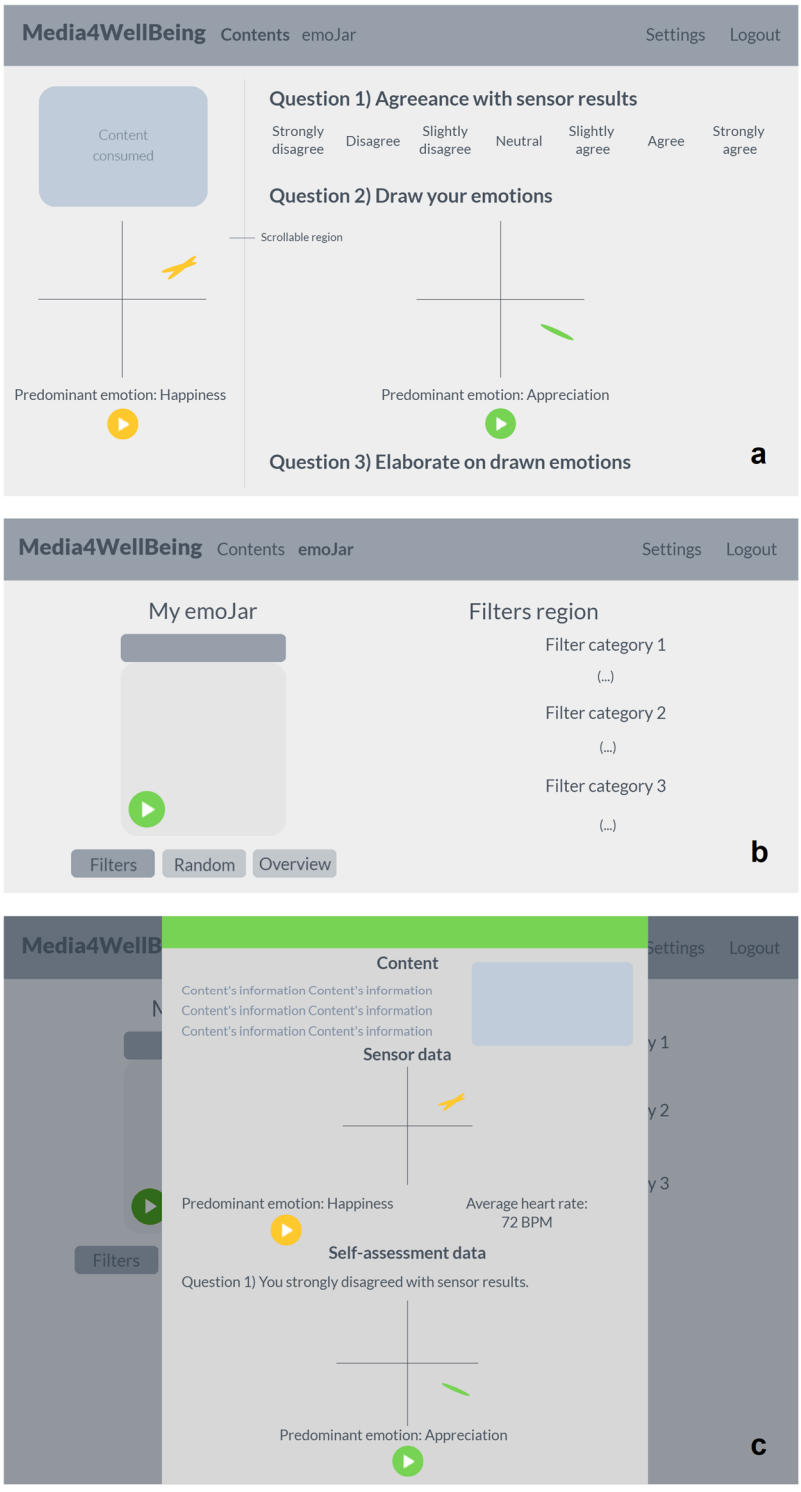

Figure 4.3 – EmoJar system's mock-up of a) the self-assessment page, b) the emoJar page, and c) an entry's structure and contents.

Since developing a system's interface and features can be a time-consuming endeavor, it was crucial to consider how the emoJar system would look and behave like. After doing so, all that remained was to dive deep into the waters of development, which resulted in what follows.

4.4 Interface Description

In this section, a presentation of all the pages and features of the emoJar system will be made. It is important to note that all pages of this system's interface have been made responsive (i.e., capable of adapting to most window and screen sizes by changing their layout), so as to allow it to be used on mobile devices (and, in the process, make it possible for the system to use some of these devices' features, like their ability to vibrate and recognize shake-based commands). This means that this system's interface can be arranged in many ways, making it necessary to mention that the following figures correspond to the emoJar system's interface on a computer monitor.

4.4.1 Initial page

The initial page (Figure 4.4) is the first one that individuals see upon accessing the Media4WellBeing web app, where the emoJar and all its related features are located. It slideshows 5 royalty-free images (url-GoodFon) that are meant to induce a relaxed state, and it presents individuals with two buttons – one that opens a prompt to sign up (i.e., register) in Media4WellBeing, and another that opens a prompt to sign in (i.e., login).

Figure 4.4 – The initial page, from which individuals can login or register on the Media4WellBeing app.

To sign up, individuals must provide a username and a password (Figure 4.5a); to sign in, they must provide the very same details they registered with (Figure 4.5b).

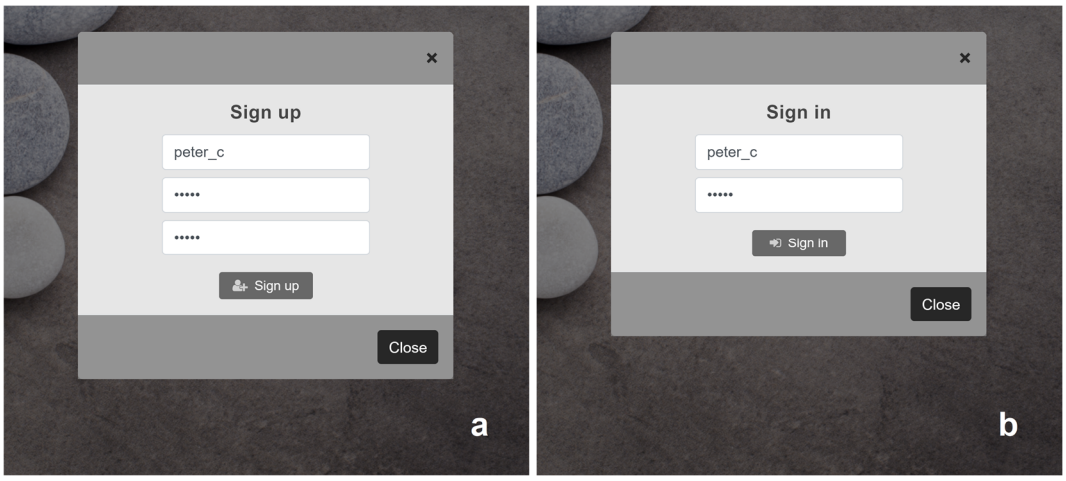

Figure 4.5 – The initial page's a) "Sign up" and b) "Sign in" prompts.

Should the provided details match the ones stored by Media4WellBeing, individuals – now users – are granted access to the app and all its features, starting with the content selection page.

4.4.2 Content selection page

Upon signing in, users are presented with the content selection page (Figure 4.6).

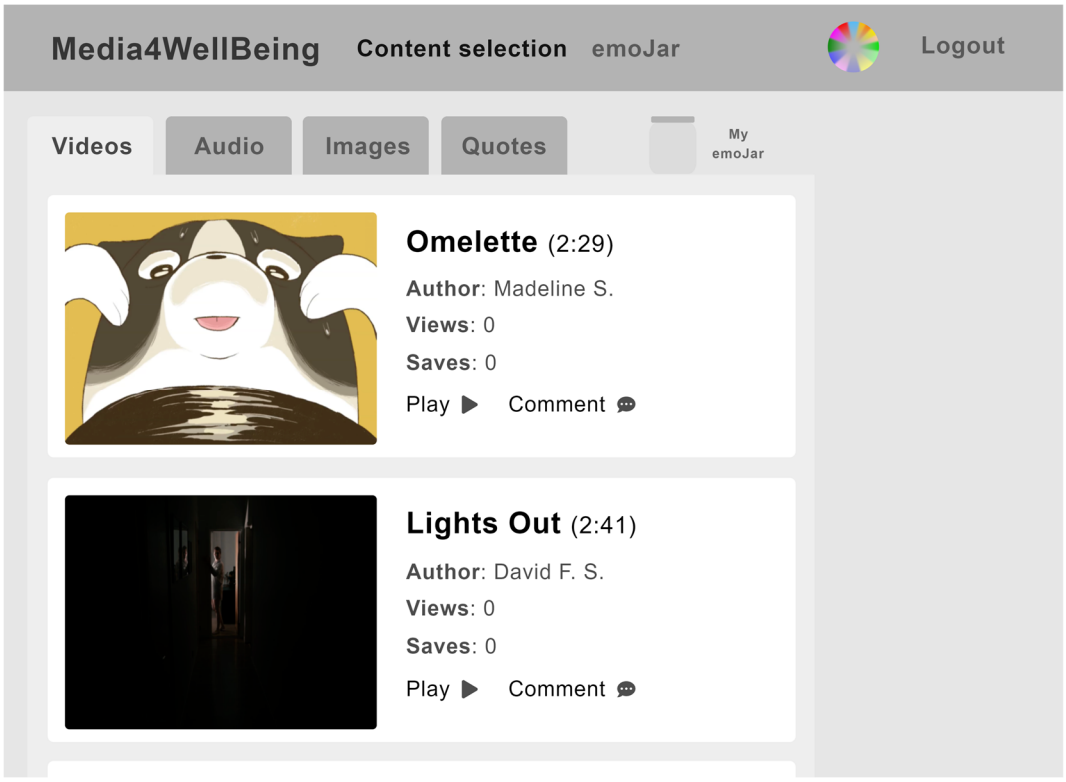

Figure 4.6 – The content selection page, where all available digital content is layed out for the user to select and consume.

From this page, users can access four kinds of digital content – videos (highlighted in this work), audio, images, and text quotes – which are distributed across

four accordingly named tabs. Each content is presented as a white card holding a thumbnail to its left, and some content-related information to its right, such as the content's title, duration (when applicable, and in parentheses), author, and number of times it has been consumed (in this case, viewed) and saved by the user. Users can readily consume any of these contents by clicking on their thumbnail, title, or "Play" prompt, or they can skip on their consumption by clicking on the "Comment" prompt, which is there so users can provide their self-assessment on content they have previously consumed and considered worthy of being saved in their emoJar (e.g., a short animation they might have seen in the past, through our system or otherwise).

If, instead, users would rather visit their emoJar, they can do so by way of the navigation bar's "emoJar" link, or the small emoJar icon (to the right of Figure 4.6's "Quotes" tab) that is always reflective of its status (being that, in this case, the emoJar is empty). When accessed in its initial and empty state, the emoJar prompts its user to consume (and eventually save and comment upon) some content (Figure 4.7).

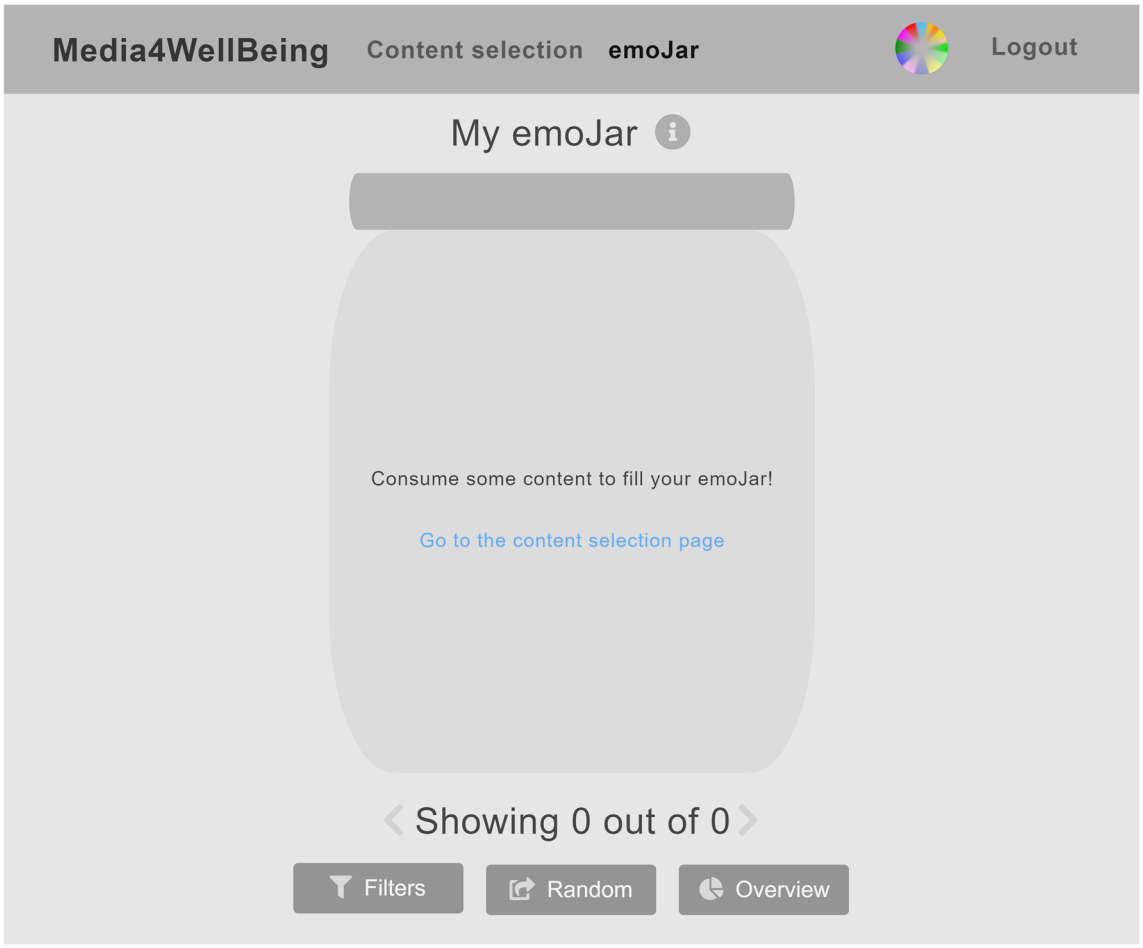

Figure 4.7 – The emoJar in its initial and empty state, prompting the user to consume some content from the content selection page.

For the time being, let's assume a video was selected, leading the user to the content reproduction page.

4.4.3 Content reproduction page

Upon selecting some content (in this instance, a video), users are directed to the content reproduction page (Figure 4.8).

Figure 4.8 – The content reproduction page: a) the consumed content (left), Media4WellBeing's emotion recognition results – in "emoPaint" form – and the user's average heart rate (center), and a colored circle representing the consumed content and the emotion that it predominantly elicited in the user, along with the "emoJar", in which users can "Save" the consumed content (right); b) once saved, users can "Comment" on the consumed content and their experienced emotions.

In it, users are able to consume their selected content (to the left of Figure 4.8a), and get real-time feedback on 1) their experienced emotions (according to Media4WellBeing's emotion recognition system, which employs the use of physiological sensors, as described in this document's section 3.2.4), and 2) their average heart rate.

1) Experienced emotions: Emotional feedback is presented to users in the previously discussed "emoPaint" form (at the center of Figure 4.8a), whose predominantly painted emotion is reflected in the emoJar section of the page (to the right of Figure 4.8a), where 1) a "Predominant emotion" text field informs the user of what emotion has been painted – and thus felt – more predominantly, and 2) a small circle representing the selected content and its type – by way of its icon – assumes the color of this emotion. Through the emoJar section, users can save/remove the content in/from their emoJar by clicking on the "Save"/"Remove" prompt, and add their self-assessment by clicking on the "Comment" prompt (Figure 4.8b).

Once the selected content is saved via the "Save" prompt, an entry in the shape and color of the above-mentioned circle – portraying a crumpled paper – is created in the emoJar page (reviewed in section 4.4.5), only contemplating the content's basic information and the data that was collected up until this point – namely, the user's experienced emotions (in "emoPaint" form) and average heart rate. Should users disagree with the collected data, or feel like adding to it, they may do so via the "Comment" prompt, which leads them to the self-assessment page (presented in the following section).

2) Average heart rate: Since every single emotion that is experienced by individuals brings about specific physiological changes, such as increased heart rate (as previously discussed in this document's section 2.5), an "Average heart rate" text field was included underneath the sensor-generated "emoPaint", allowing users to be informed of how their bodies respond to some content and the emotions it makes them experience. For as long as the user's average heart rate is being estimated, a discrete light pink heartbeat animation plays in the background, mimicking the heart's relaxation and contraction (i.e., thump-thump). Mobile device (i.e., smartphone and tablet) users also get to feel their heartbeat through a vibration pattern that mimicks the referred heart's behavior. The background animation, vibration pattern, and "emoPaint" generation are synchronized with the user's average heart rate to promote a sense of closeness (Janssen et al., 2010).

4.4.4 Self-assessment page

In the self-assessment page (Figure 4.9), users are able to 1) rate how much they agree with the recognized emotions; 2) draw their own "emoPaint", to give their personal perspective on what emotions they have felt; 3) elaborate on why they have felt said emotions (e.g., "I felt X because the content reminded me of Y"); and 4) elaborate on what made the consumed content memorable (e.g., its message), making it possible for users to expand upon their thoughts and perceptions about the selected content, its emotional impact, whether it evoked some memory, and ultimately what made the content worth saving in their emoJar.

Figure 4.9 – An overview of the self-assessment page: in a), the consumed content, recognized emotions (in "emoPaint" form), and user's average heart rate; in b) and c), the user's self-assessment.

In the above example (Figure 4.9), we can see that the user slightly agreed with the recognized emotions (Figure 4.9b's question 1), in that he 1) did not experience any sort of "Enthusiasm" (in orange), 2) did experience a hint of "Sadness" (in blue), as well as some "Interest" (in bisque) and "Happiness" (in yellow), and 3) predominantly felt "Appreciation" (in green) (Figure 4.9b's question 2). Next, he provided an explanation as to why he experienced those emotions (evoked memories) (Figure 4.9c's question 3), what made the consumed content memorable (some of its characteristics, as well as its

ability to evoke fond memories) (Figure 4.9c's question 4), and by eventually clicking "Finish" (bottom of Figure 4.9c), he associated his self-assessment to its respective emoJar entry.

It is important to note that emotions drawn – and therefore felt – by the user outweigh those recognized by sensors. This means that an emoJar entry – represented by the aforementioned colored circle – adopts the color of whatever emotion was predominantly drawn by users (Figure 4.10b), rather than the one predominantly recognized by sensors (Figure 4.10a).

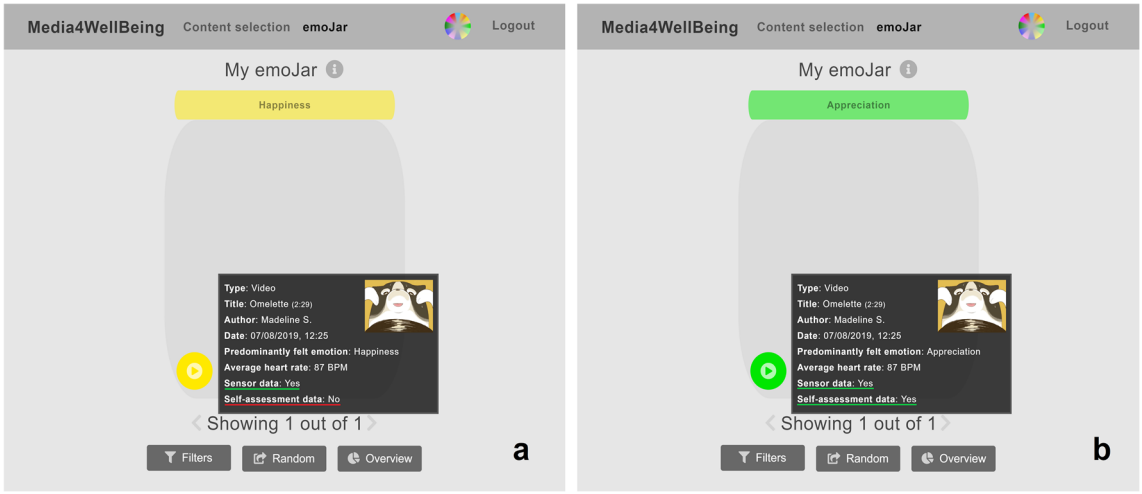

Figure 4.10 – The potential difference in an emoJar entry's color: a) when it does not include the user's self-assessment vs. b) when it does include the user's self-assessment.

Having reviewed how users come to access, consume, save, and comment on digital content and its emotional impact, it is time we review the emoJar itself.

4.4.5 EmoJar page

It is in this page that users find their emoJar, in which they collect and recall digital content that was impactful to them and may have positively contributed to their psychological wellbeing. From here, users can do 5 things: 1) read up on what the emoJar is and how it works; 2) access their emoJar entries; 3) filter through their emoJar entries; 4) extract random emoJar entries; and 5) get an overview of their emoJar use and experienced emotions.

1) Reading up on what the emoJar is and how it works: Before – and even after – they start interacting with their emoJar, users can inform themselves about what it is and how it works. To do so, users only need to click on the "ⓘ" icon to the right of

the “My emoJar” text (Figure 4.11a), which prompts a new window with text and images that concisely describe the purpose and features of the emoJar (Figure 4.11b).

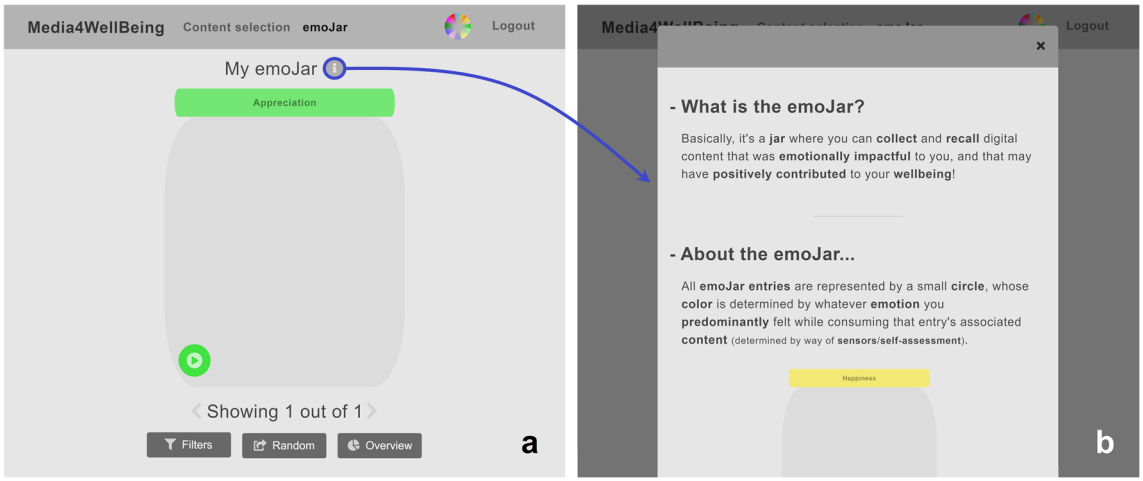

Figure 4.11 – The emoJar’s description and instructions: by clicking on the “ⓘ” icon in a), users can read up on what the emoJar is and how it works in b).

2) Accessing emoJar entries: To access and review an emoJar entry, users need only to click on it (Figure 4.12).

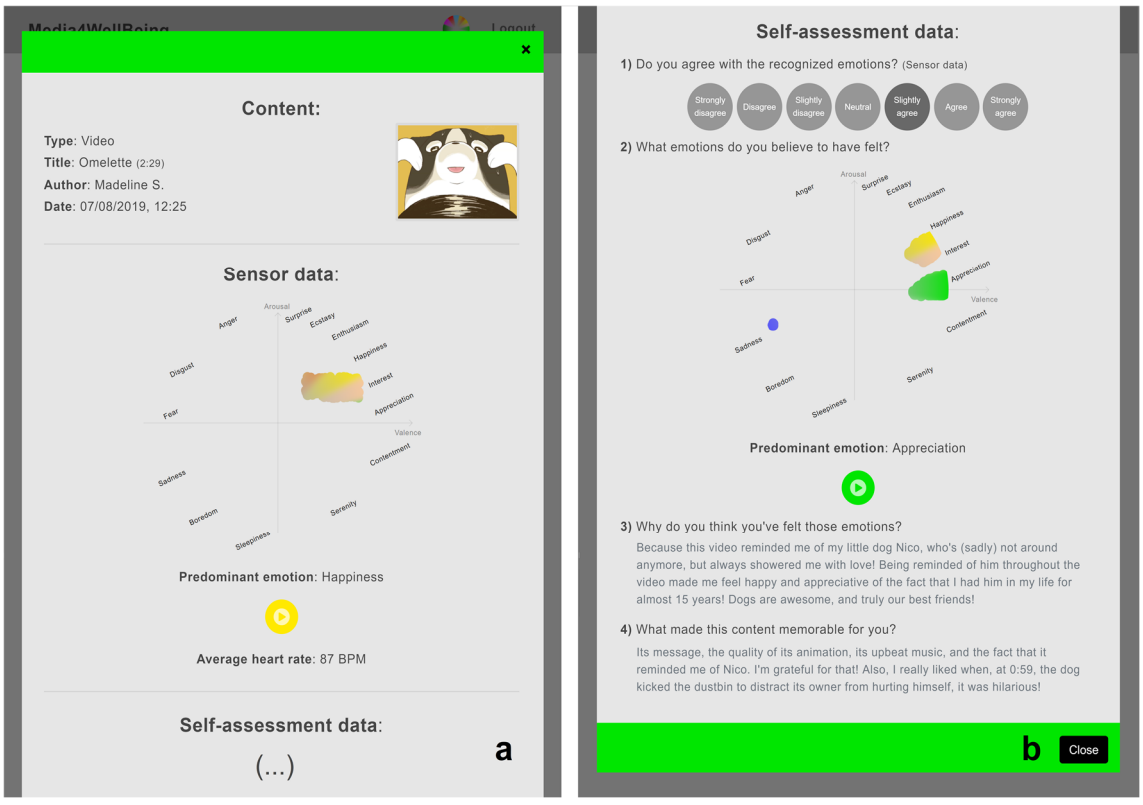

Figure 4.12 – Overview of an emoJar entry: in a), some basic information about the entry’s associated content, and all collected sensor data; in b), the user’s self-assessment about the entry’s associated content.

Once an entry is clicked, a new window emerges, hosting all the information shown on that entry's preview (Figure 4.10b) in greater detail – namely, 1) the associated content's thumbnail, type, title, author, and date it was saved in the emoJar; 2) the emotions and average heart rate that were recognized by Media4WellBeing's sensors throughout that content's consumption (Figure 4.12a); and 3) the user's self-assessment, which includes his agreeance with the recognized emotions, his own "emoPaint" describing what emotions were felt, and what ultimately made the content worthy of being saved in his emoJar (Figure 4.12b).

3) Filtering emoJar entries: In time, users' emoJar start to fill up, making it harder for them to, for instance, find some content that was particularly impactful, or compare how differently they emotionally responded to that same content upon multiple savings. To address this, a filter section (Figure 4.13) was included in the emoJar page, allowing users to filter the emoJar and its entries.

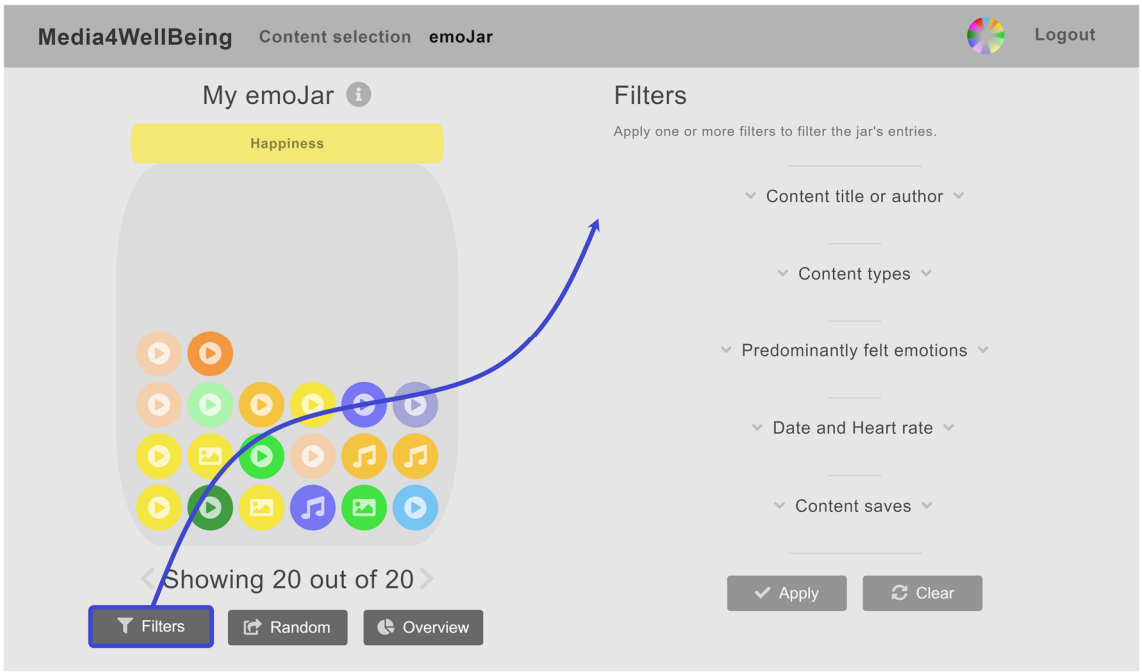

Figure 4.13 – An overview of the emoJar's "Filters" section (to the right), accessible by clicking on the "Filters" button (to the left).

Sliding in from the right and doubling as a legend for what each entry's icon and color represents (i.e., its associated content type and predominantly felt emotion), this filter section is divided into 5 expandable and simultaneously accessible regions, whose filters can be individually or collectively applied to find specific entries. **Note**: For simplicity, the following figures will only show the discussed regions.

The first region – "Content title or author" – contains a text field that users can employ to find entries by their associated content's title or author (provided in full, or partially), and the second region – "Content types" – hosts a set of checkboxes that allow users to find entries by their associated content's type (video, audio, image, or text quote) (Figure 4.14).

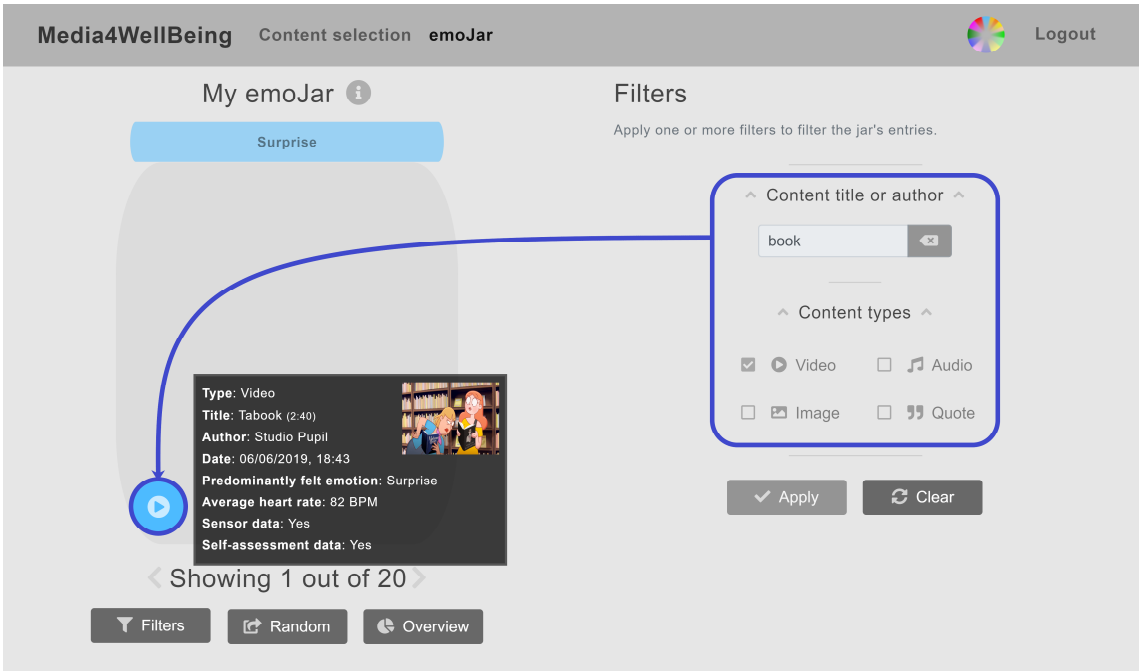

Figure 4.14 – The emoJar's state after applying the "Content title or author" and "Content types" filters. For the "Content title or author" filter, the word "book" was provided, as the user could not remember the full title of the video he was looking for ("Tabook").

The third region – "Predominantly felt emotions" – contains 2 things: 1) a set of 14 buttons – laid out as a wheel of emotions (Figure 4.15a), or arranged alphabetically (Figure 4.15b) or by color (Figure 4.15c) – that allow users to find entries by whatever emotion they have predominantly felt upon consuming these entries' associated content; and 2) a set of 4 checkboxes (2 for "Sensor data", and another 2 for "Self-assessment data") that allow users to find entries by whether or not they contain sensor and/or self-assessment data (beneath Figure 4.15's emotions).

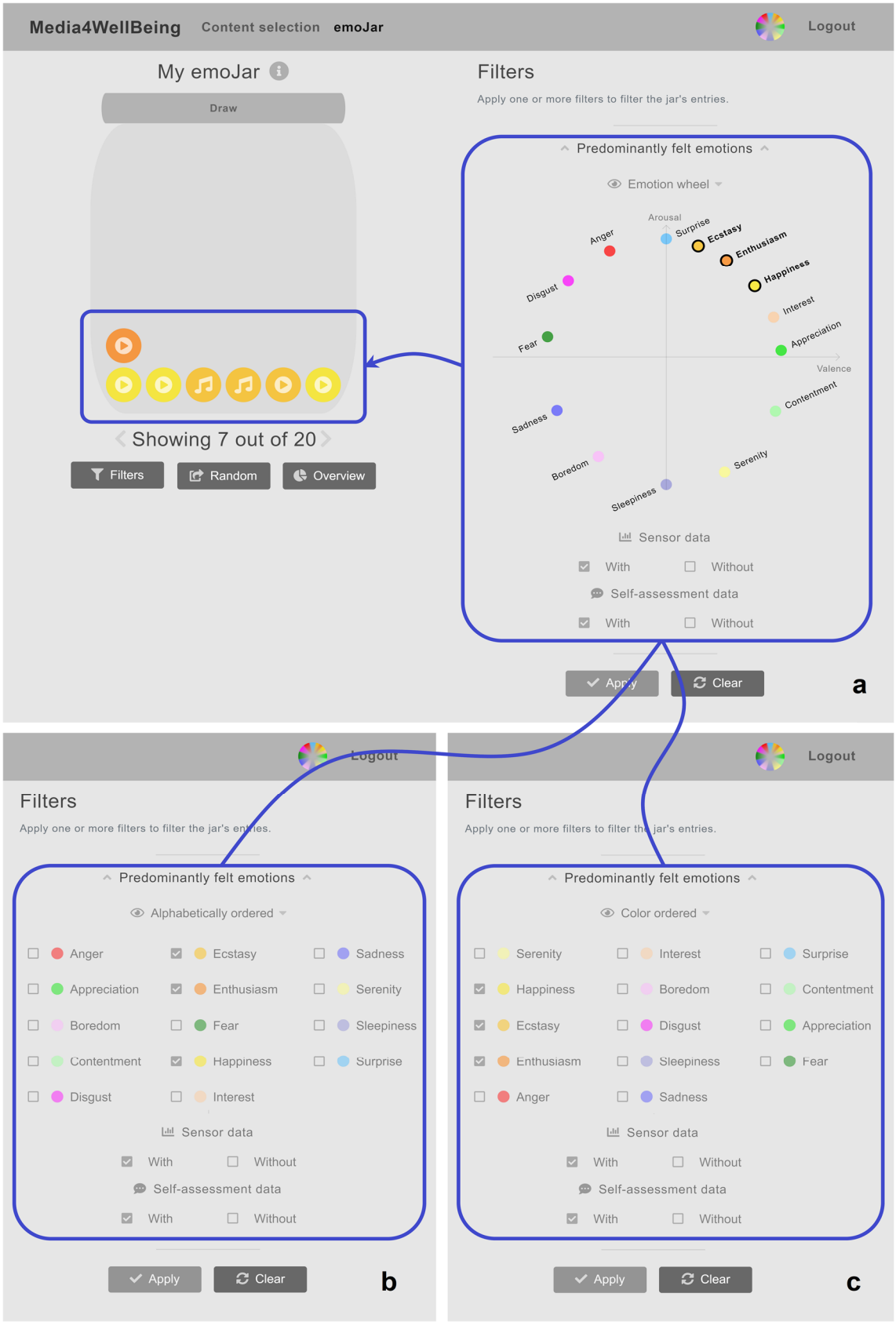

Figure 4.15 – The emoJar's state after applying the "Predominantly felt emotions" filters. In a), b), and c) – where 3 different arrangements of all available emotion filters are presented – we can see that the user wishes to find entries whose predominant emotions are "Ecstasy", "Enthusiasm", and "Happiness", and include sensor and self-assessment data.

The fourth region – "Date and Heart rate" – contains 2 checkboxes, the first being assigned to "Date", and the second to "Heart rate". Upon clicking on the "Date" checkbox, a new window emerges, hosting two date fields that users can fill out to find entries whose associated content was saved in the emoJar at a particular date or date interval (Figure 4.16).

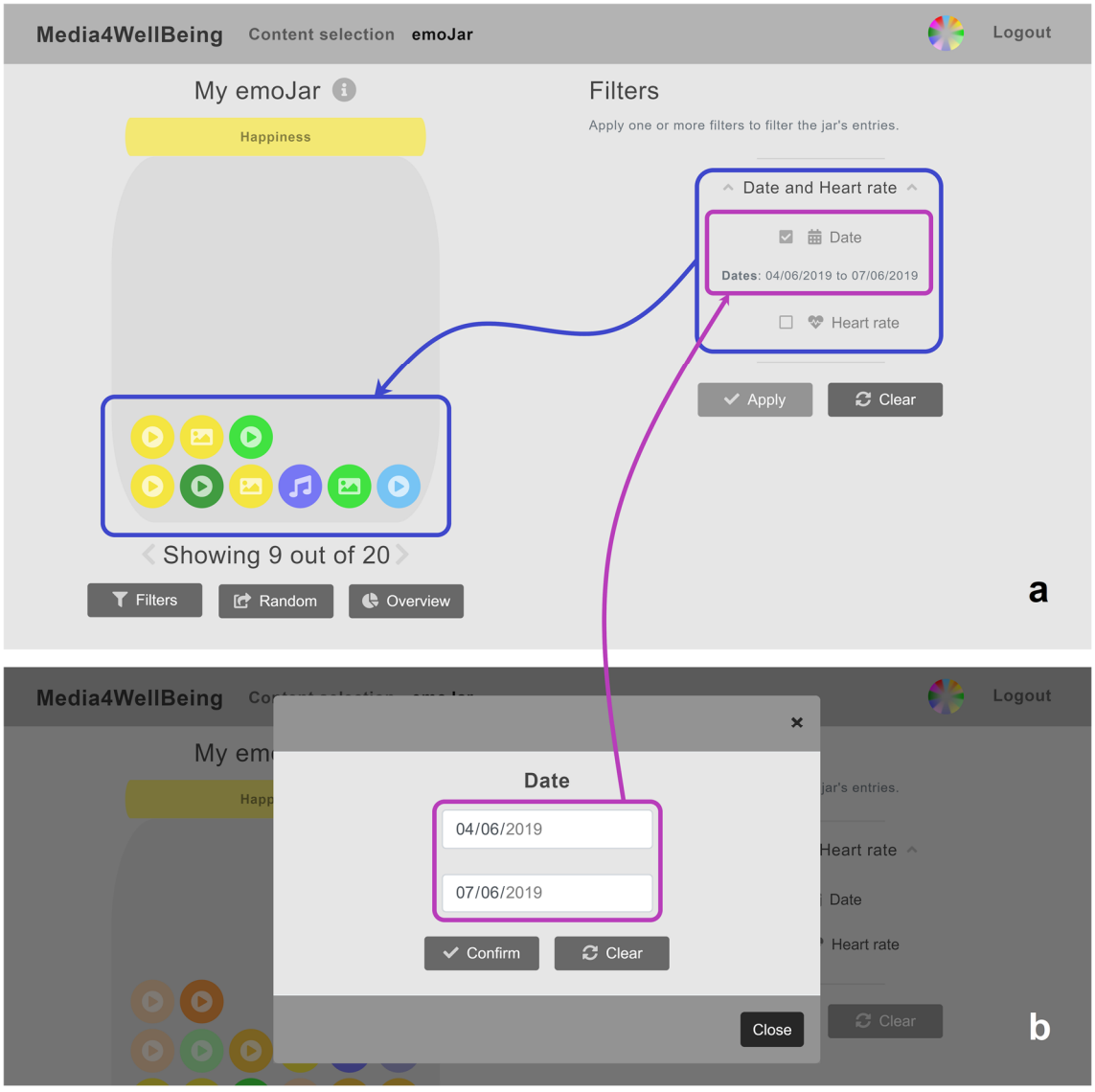

Figure 4.16 – The emoJar's state after applying the "Date" filter: in b), a date range is provided, with all matching results being presented in a).

Upon clicking on the "Heart rate" checkbox, a new window also emerges, this one hosting 4 different ways of providing a particular heart rate (in beats per minute, or BPM) or heart rate interval (BPM ± Tolerance), which is then used to find entries by the user's average heart rate at the time of the associated content's consumption (Figure 4.17).

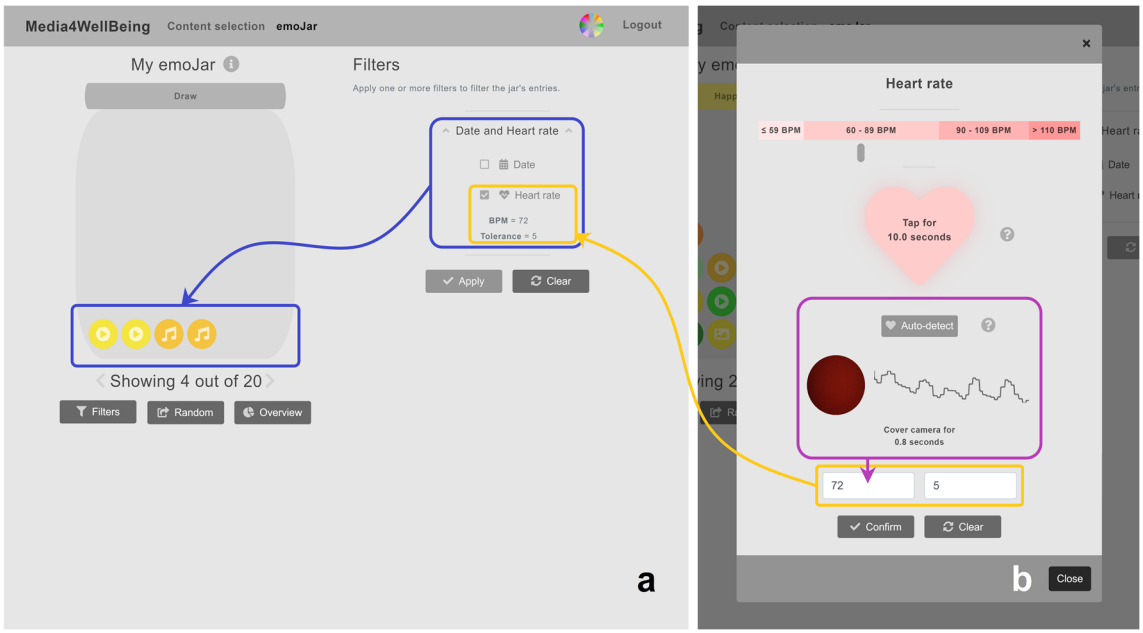

Figure 4.17 – The emoJar's state after applying the "Heart rate" filter: in b), the user employs the "Auto-detect" mechanism to estimate and use his own heart rate in the filtering process, whose results are presented in a).

The first "Heart rate" input method is a slider that users can drag along a multicolored heart rate scale to their desired heart rate; the second input method is a tapping mechanism that allows users to insert their own heart rate by having them 1) press their carotid artery (to the side of the trachea) with their fingertips, and 2) tap a heart icon to the frequency of their heartbeat (just once per heartbeat, as feeling the two thumps of one's heart can be challenging, and tapping the heart icon to replicate this thump-thump pattern even more so); the third input method also allows users to insert their own heart rate by employing the device's camera to automatically detect these users' heart rate – it operates by 1) having users place one of their fingers on the camera of their device (computer, smartphone, or tablet) for 30 seconds, and 2) measuring changes in the light intake of the device's image sensor, which is affected by the volume of blood passing through the user's finger with each heartbeat; the fourth and final input method is a text field where users can simply type their desired heart rate. Regardless of what input method is employed, the slider's placement, heart icon's color, and text field change to reflect the provided or detected heart rate. A tolerance text field is also provided, allowing users to find entries within a given heart rate interval (e.g., if "BPM" is set to 75, and "Tolerance" is set to 15, users can expect to find entries where the user's average heart rate at the time of the associated content's consumption was between 60 and 90 BPM, both inclusive).

The fifth and final region – "Content saves" – contains two options: "First", which allows users to find the first emoJar entry that was created about every single saved content (e.g., the user consumed, saved, and commented video X multiple times, but only wishes to review the sensor and/or self-assessment data that is related to the first time that video was saved) (Figure 4.18a); and "Repeated", which allows users to find and put together all emoJar entries about every repeatedly saved content (e.g., multiple entries about one particular content are scattered throughout the jar, and the user wants to quickly ascertain how many they are and how they compare) (Figure 4.18b).

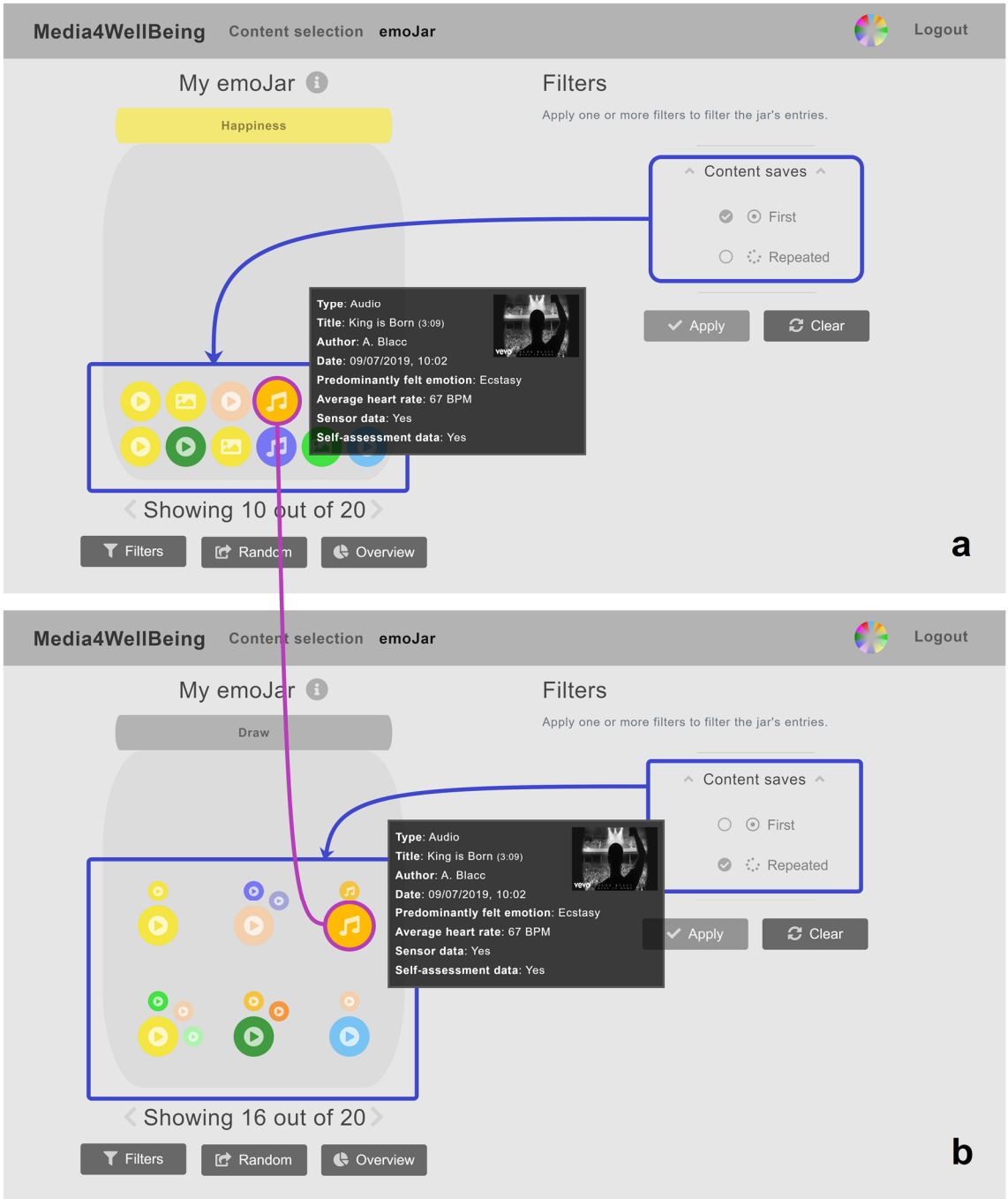

Figure 4.18 – The emoJar's state after applying the "First" and "Repeated" filters.

By way of conveniently placed tooltips, users are always informed of what filters are currently active, should they close any of the described filter regions (Figure 4.19a) or the entirety of the "Filters" section (Figure 4.19b). Both before and after applying filters, the amount of entries in the emoJar is shown beneath it, and by way of its color and text, the emoJar's lid informs the user of what predominant emotion is most present. Should two or more predominant emotions be equally present, the emoJar's lid turns grey and reports a "Draw".

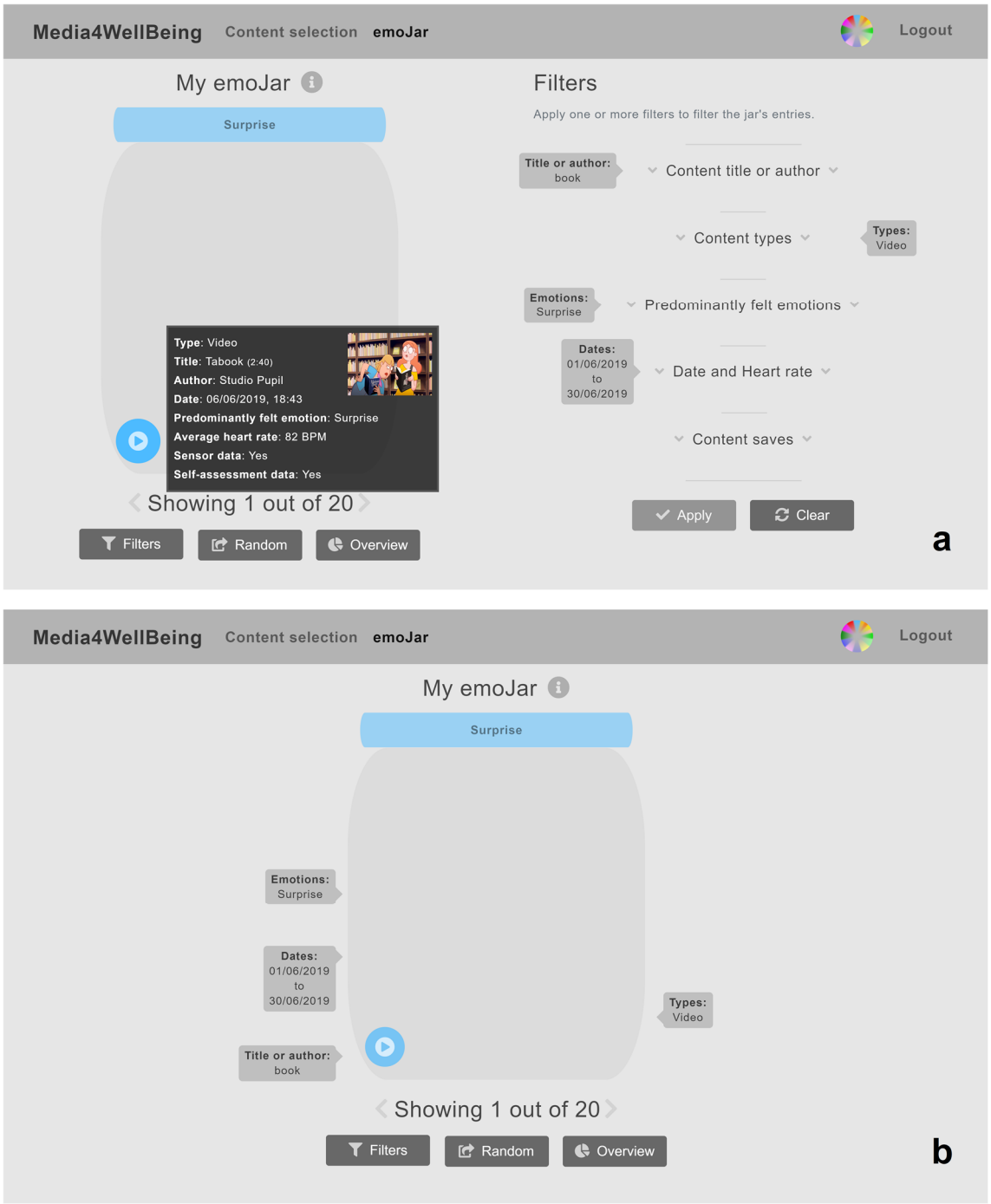

Figure 4.19 – The emoJar's tooltips: informing of what filters were selected and applied when a) a filter region is closed, and b) when the entire "Filters" section is closed.

4) Extracting random emoJar entries: When users do not feel like putting much thought into what emoJar entries they want to access and review, they can extract a random entry from their emoJar by either 1) pressing the "Random" button below the emoJar (Figure 4.20a), or 2) shaking their mobile devices in the way suggested by this button's icon (which resembles a mobile device being shaken to the side) (Figure 4.20b). Doing any of these gets one randomly selected entry out of the user's emoJar (introducing a flavor of serendipity to our system (Chambel, 2011)), which can then be opened or returned to the emoJar by any of the methods described above.

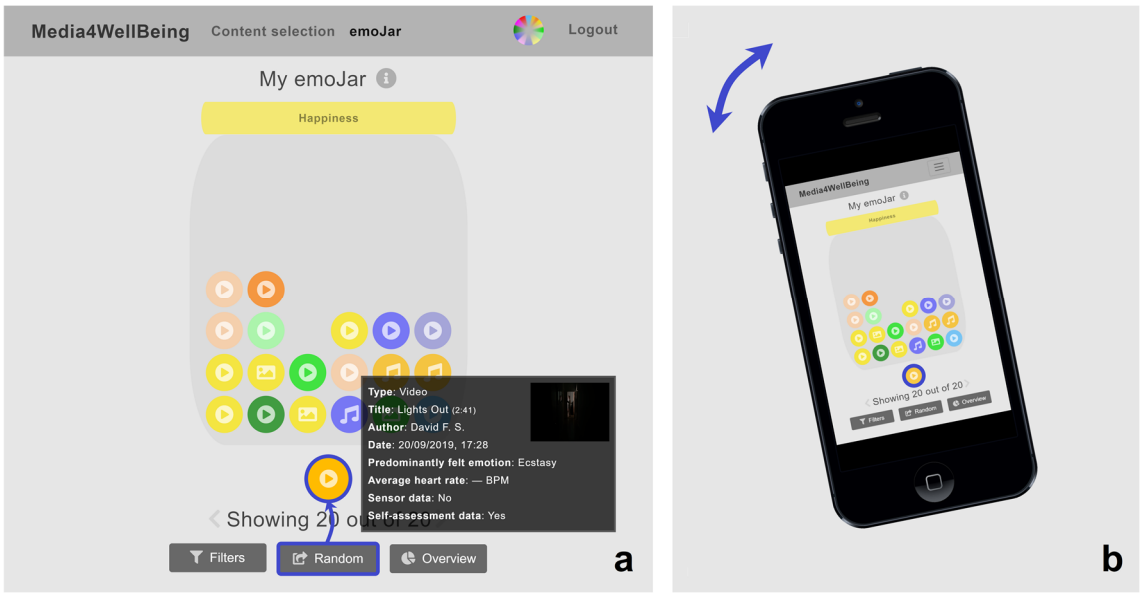

Figure 4.20 – Extracting a random emoJar entry: in a) by way of the "Random" button, and in b) by shaking one's device.

5) Getting an overview of one's emoJar use and experienced emotions: Upon clicking on the "Overview" button, users can learn more about their digital content consumption habits, experienced emotions, and overall emoJar system's use. This is achieved through two distinct but complementary views – the "Tag clouds" view and the "Statistics" view.

In the "Tag clouds" view (which was inspired by the MovieClouds application and Media4WellBeing's "emoClouds" view), users are able to compare two tag clouds that report on what emotions they have predominantly felt according to Media4WellBeing's emotion recognition system (Figure 4.21a) and their own self-assessments (Figure 4.21b). On either perspective, clicking on a tag (i.e., emotion) causes a tooltip to appear with the number of times that said emotion has been predominantly felt.

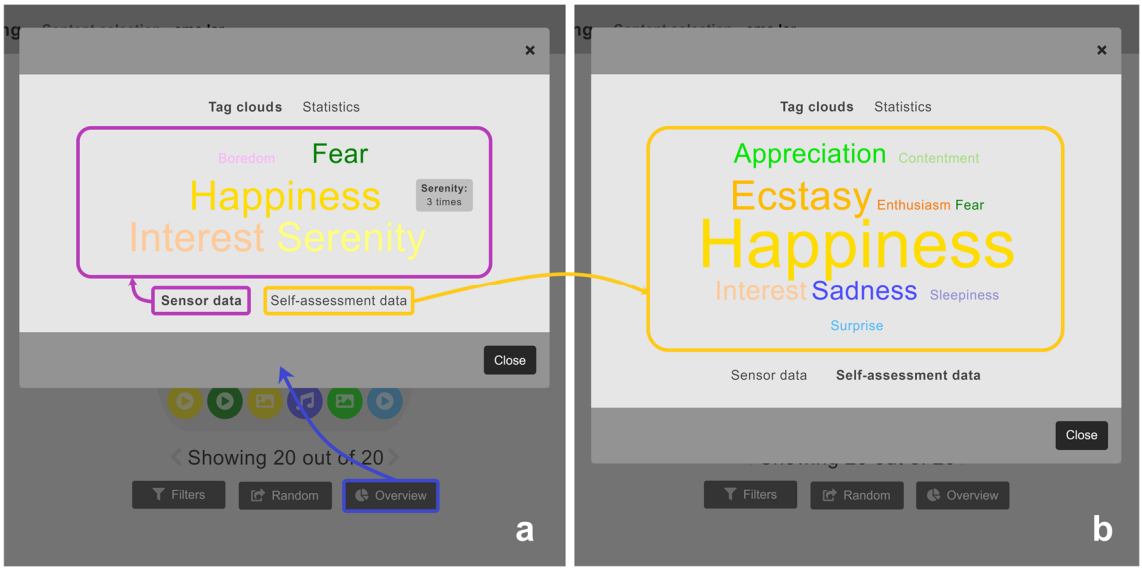

Figure 4.21 – Tag cloud's tab of the emoJar system's "Overview": the tag clouds in a) and b) respectively report on what emotions have been predominantly felt by the user according to Media4WellBeing's emotion recognition system and the user's self-assessments. By comparing the two, we can see that the user has never predominantly felt "Boredom" or "Serenity".

In the "Statistics" view (Figure 4.22), users are able to review 1) how many entries correspond to video, audio, images, and text quotes, 2) how many entries include sensor and self-assessment data, 3) how emotions are distributed across all emoJar entries (in volume and percentage) according to Media4WellBeing's sensors and their own self-assessments (Figure 4.22a), 4) their general agreeance with sensor data (namely, the emotions they have recognized), 5) the average amount of words they type with each self-assessment, 6) the dates when the first and most entries were saved to the emoJar, and 7) their average heart rate whenever content is consumed while using Media4WellBeing's sensors (Figure 4.22b).

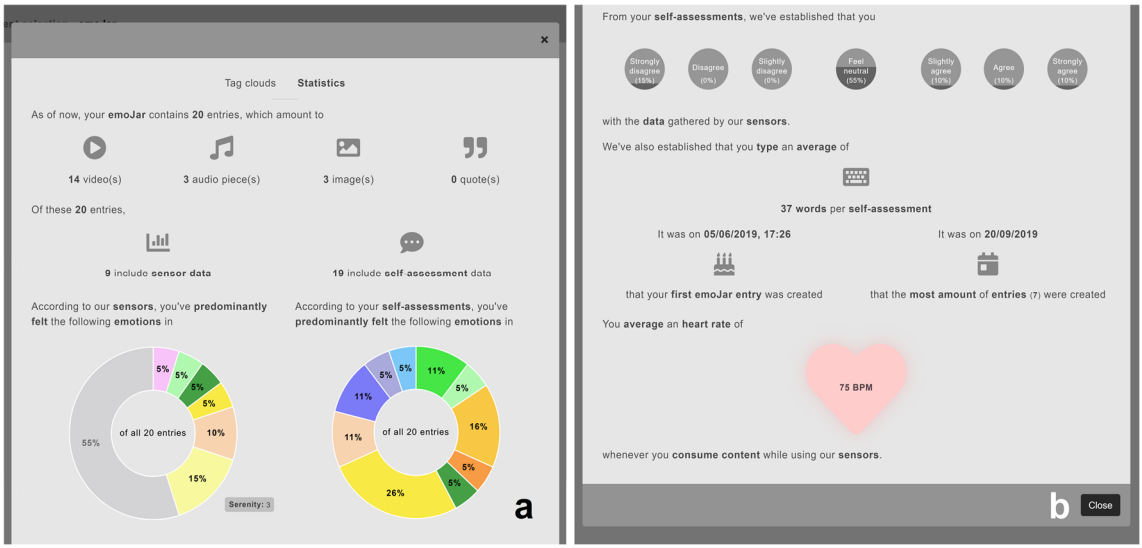

Figure 4.22 – Statistics tab of the emoJar system's "Overview", where users can find an assortment of information about their emoJar system's use.

One feature that is common to all pages – but happens to be especially noticeable on the emoJar page, which is why we have waited until now to discuss it – is the ability to change the emotion representation being employed by the emoJar system.

To the right of the system's navigation bar, there is a multicolored circle that represents and informs the user of the emotion representation being currently employed in all emotion-related elements of the emoJar system. When clicked, this multicolored circle gives rise to a new window hosting 3 emotion representations, of which only one can be selected at any given time.

The first emotion representation (the system's default, in Figure 4.23b) is a heavily modified version of Media4WellBeing's emotion wheel (Figure 4.23c), whose colors – at least when it came to the "Surprise", "Ecstasy", "Enthusiasm", "Interest", "Appreciation", "Sleepiness", and "Boredom" emotions – felt insufficiently distinct to be distinguished by users (e.g., when studying a sensor-generated "emoPaint", it could prove challenging for users to discern where "Ecstasy" started and "Enthusiasm" ended).

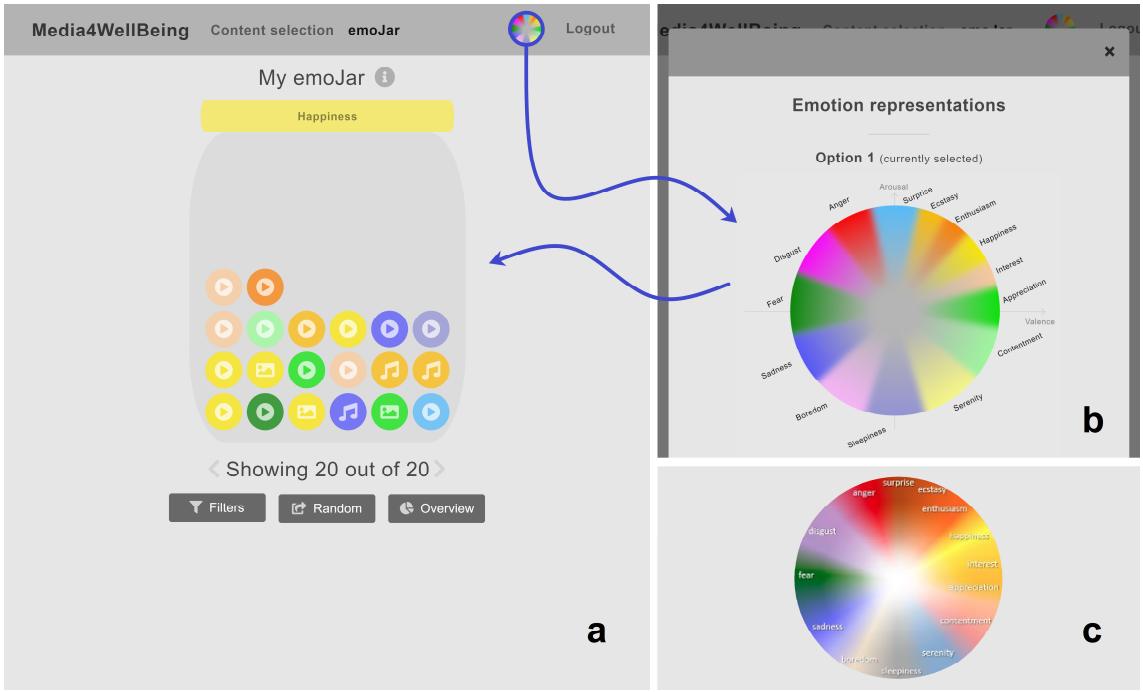

Figure 4.23 – The emoJar's look when the first emotion representation (the system's default) is selected.

For this representation, we paired Media4WellBeing's adopted emotions with its respective color in Plutchik's Wheel of Emotions (or ones that resembled it whenever we felt that the user's ability to distinguish between certain emotions was at stake),

which resulted in our system's most distinctive emotion representation, whose "Surprise" became light blue (as in Plutchik's Wheel of Emotions); "Ecstasy" became mango colored (as Plutchik's color for "Ecstasy" was not that different from the yellow of "Happiness" and the light yellow of "Serenity"); "Enthusiasm" became a saturated orange (as "Enthusiasm" can sometimes be thought of as an intense interest or anticipation, which are respectively light orange and orange in Plutchik's Wheel of Emotions); "Interest" became bisque (as Plutchik's light orange for "Interest" conflicted with our mango color for "Ecstasy"); "Appreciation", "Contentment", and "Sleepiness" respectively became green, light green, and lavender blue (for lack of more appropriate colors); and "Boredom", "Sadness", "Fear", "Disgust", and "Anger" became of the same color that is found in Plutchik's Wheel of Emotions.

The second emotion representation (Figure 4.24b) is heavily inspired by the color arrangement of Plutchik's Wheel of Emotions (Figure 4.24c). Contrasting with the first emotion representation, in which we sought to associate Media4WellBeing's adopted emotions with their corresponding color in Plutchik's Wheel of Emotions, in this second emotion representation no attempts were made at pairing certain colors with certain emotions – we just referenced Plutchik's color arrangement to create an emotion representation whose colors, while distinct, transition more naturally.

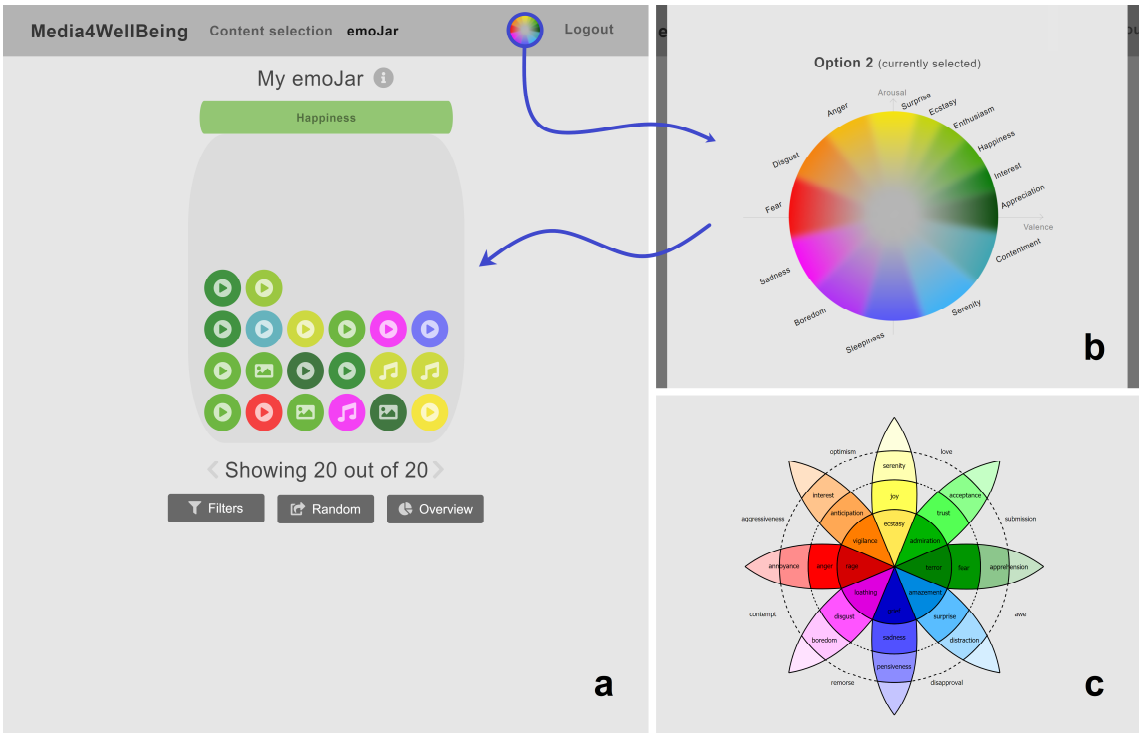

Figure 4.24 – The emoJar's look when the second emotion representation is selected.

The third emotion representation is highly inspired by the color arrangement of a 2004 Geneva Emotion Wheel prototype (Tran, 2004) we found when studying this model of emotion, presented in this document's section 2.3.2. As was the case with the second emotion representation – where no attempts were made to match specific colors with specific emotions – we merely followed the color arrangement of Tran's proposed prototype (Figure 4.25c) to create an emotion representation (Figure 4.25b) that 1) serves as an alternative to both representations previously described, and 2) has colors that, while made to be as distinct as possible, transition more naturally than the ones making up the first emotion representation.

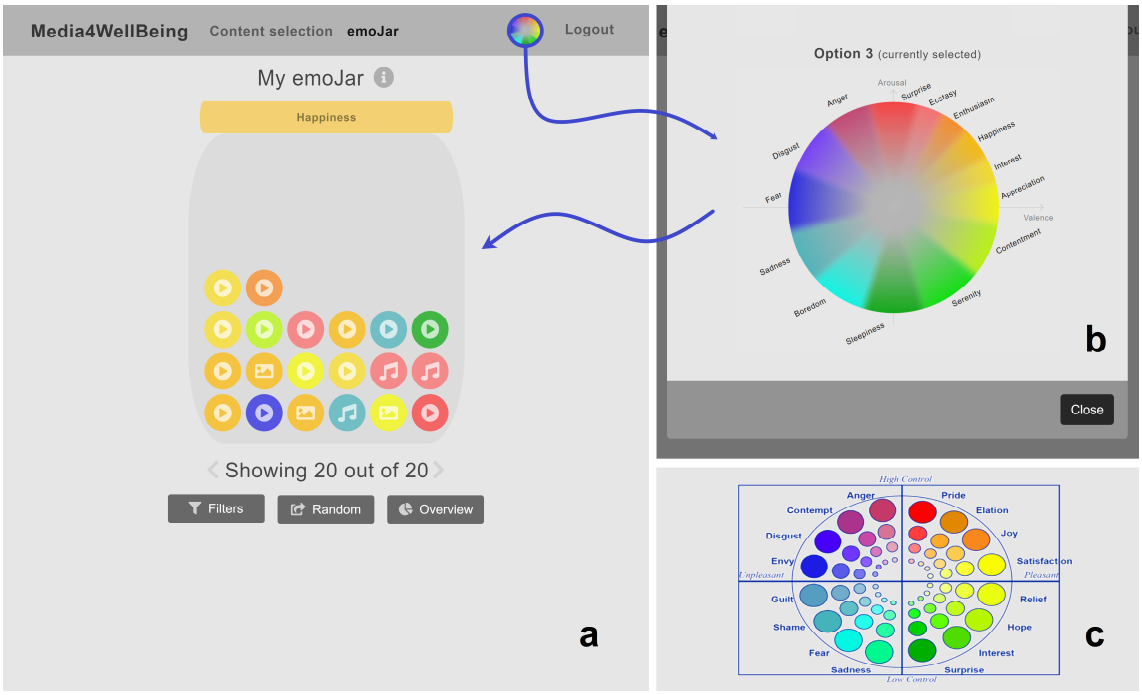

Figure 4.25 – The emoJar's look when the third emotion representation is selected.

What drove the development of the last two emotion representations was the research carried out in this document's section 2.4, where it became clear that color-emotion associations can vary significantly between individuals due to preference and culture. In light of this conclusion, we thought it would be useful to give alternative emotion representations to our system's users and so, upon selecting one of these three emotion representations, every single emotion-related element of the emoJar system changes.

4.5 Summary

In this chapter, we began by describing the requirements and visual representations (i.e., sketches and mock-ups) that informed the design of the emoJar system, made to allow its users to collect, search for, browse through, access, recall, and reexperience digital content that not only made them experience a number of emotions, but ultimately might have contributed to their psychological wellbeing.

We then described each page of the system, starting with the initial page (where users sign up and/or sign in), and following it up with the content selection page (where, as the name implies, users select whatever digital content they wish to consume), the content reproduction page (where users consume their selected content, get real-time feedback on their experienced emotions and average heart rate, and save the consumed content in their emoJar), the self-assessment page (where users comment on what emotions they felt, why they felt them, and what made their selected content memorable and worthy of being saved), and the emoJar page (where all saved digital content and its respective data – gathered by sensors and/or supplied by users – is stored, and where and through which users can collect, search for, browse through, access, recall, and reexperience digital content that, to them, was meaningful, memorable, and emotionally impactful).

As each page of the system was described, we mentioned some details that, while not entirely innovative, make the system more interesting to use (e.g., the ability to use one's own heart rate – determined through a tapping mechanism or the device's camera – to filter and find emoJar entries). In the chapter that follows, we will go over the implementation of these and other details.

Chapter 5

EmoJar System's Implementation

In the previous chapter, we went over how the emoJar system looks and behaves. In this chapter, however, we focus more on the aspects related to its implementation, such as 1) the tools and web technologies used to respectively develop and power the system's functionalities (whose implementation is also discussed); 2) the system's architecture and data model; 3) the system's limitations; 4) the challenges that were faced; and 5) the decisions that were made.

5.1 Employed Tools and Web Technologies

The only tools that were used to develop and implement the emoJar system's features were Notepad++ and XAMPP.

- **Notepad++** is a simple text and source code editor. It was chosen for its familiarity and tabbed editing support, which made it possible to edit multiple open files within a single window;
- **XAMPP** is a software distribution that we employed to easily create a local web server for testing purposes (more specifically, to frequently test the emoJar system on mobile devices).

When it comes to web technologies, we used 4 standard web development languages (HTML, CSS, JavaScript, and SVG), 1 web framework (Bootstrap), and 7 libraries (Animate.css, Font Awesome, jQuery, D3, Chart.js, Popper.js, and wordcloud2).

Web development languages:

- **HTML** (short for **HyperText Markup Language**) is a markup language that is used to structure and present web pages and its contents (text, images, videos, buttons, links, etc.). It essentially works by surrounding raw text with tags (i.e., words between angle brackets) that web browsers interpret to render a web page in the way that was intended by its author (e.g., "Hello" is raw text that, when enclosed by " " and " " tags, is displayed as a paragraph). It is currently in its fifth version, HTML5;
- **CSS** (short for **Cascading Style Sheets**) is a style sheet language that is used to style a web page and its elements (e.g., make the web page's background gray, its font "Calibri", its buttons black with white text, etc.). It operates by 1) alluding to the elements of a web page through their respective HTML tag or attributes, and 2) setting its properties to certain values (e.g., "color: red;"). It is currently in its third version, CSS3;
- **JS** (short for **JavaScript**) is a scripting language that makes it possible for web pages to do more than just sit there and display static information for users to look at, essentially establishing how they should behave at any given time (e.g., what should happen when a web page is fully loaded, when a specific element is clicked, etc.). JavaScript's most notable features are 1) its ability to dynamically access and change web page's HTML and CSS, and 2) the fact that it offers a wide range of frameworks and libraries which allow web developers to create highly interactive and dynamic web pages;
- In a web development context, **SVG** (or **Scalable Vector Graphics**) is an XML-based markup language that allows web developers to describe – and web browsers to interpret and render – two-dimensional vector graphics (or SVG's) that can 1) be manipulated through CSS and JavaScript, 2) interacted with, and 3) given animations. Being vector-based, there is no degradation or loss of fidelity when these SVG's are scaled up or down to respectively accomodate for larger or smaller-sized screens, which is useful when trying to make responsive and mobile-friendly web pages;

Web frameworks:

- **Bootstrap** (formerly known as **Twitter Blueprint**, and sometimes referred to as **Twitter Bootstrap**) is a free, open source HTML, CSS, and JavaScript framework that is used for the development of responsive and mobile-friendly web pages. Bootstrap's most notable feature is its grid system, which essentially asks web developers how they want their web page's elements to be arranged on very small, small, medium, large, and extra-large screens;

Libraries:

- **Animate.css** is a free, open source CSS library with dozens of animations that can be applied to a web page's elements (e.g., make an element slide in from the left);
- **Font Awesome** is an icon set and toolkit based on CSS;
- **jQuery** is a JavaScript library that basically simplifies JavaScript programming in that it uses a simpler syntax. While it was not explicitly employed in our work (as in, we did not do any actual programming with jQuery), it became necessary to include it, as the following libraries depended on it;
- **D3** (short for **Data-Driven Documents**) is a JavaScript library used to create dynamic, interactive data visualizations. It makes use of the widely implemented HTML, CSS, and SVG standards (even if its size and complexity make it somewhat intimidating and confusing to learn);
- **Chart.js** is an open source JavaScript library used to generate different types of charts (in our case, doughnut charts);
- **Popper.js** is a JavaScript library used to manage "poppers" in web applications ("poppers" being elements that "pop out" to inform web page users, such as tooltips);
- **wordcloud2** is a JavaScript library used to generate tag clouds (in our case, the sensor/self-assessment data tag clouds).

5.2 EmoJar System's Architecture

As shown by Figure 5.1, the emoJar system (running locally in the user's device) is composed by 3 layers.

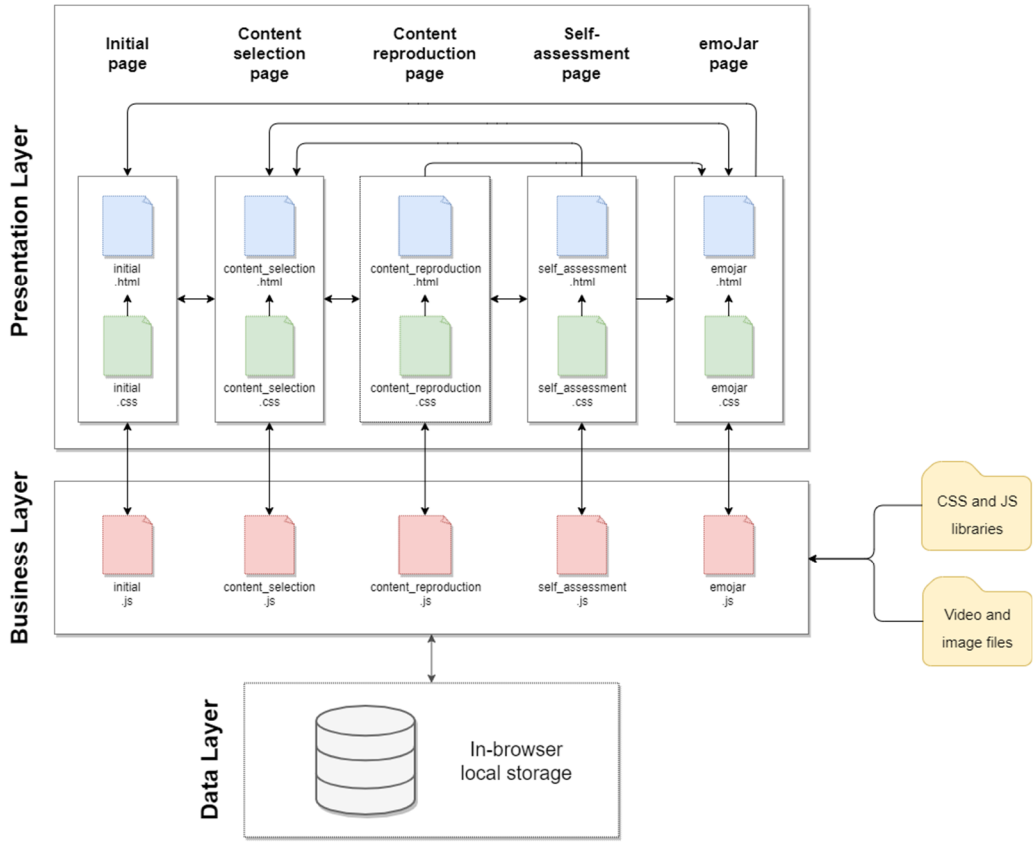

Figure 5.1 – EmoJar system's breakdown diagram.

The top-most layer is the presentation layer. It essentially corresponds to the user interface, which is used to interact with the emoJar system, and – in our case – is accessible through a web browser. This layer comprehends 5 HTML and CSS files that, put together, make up each page of this interconnected 5-page system.

The central layer is the business layer, which contains the logic driving the system's core capabilities. Said logic is distributed across 5 JavaScript files, one for each page of our system. Each file does essentially 3 things – it 1) dynamically accesses and changes each page's HTML and CSS to reflect the user's actions and the system's state, 2) redirects users through each page of the system, and 3) communicates/accesses all user-related data to/in the data layer. This layer (i.e., the business layer) serves itself of two quickly accessible folders – one for the aforementioned CSS and JS libraries, and another for the system's videos (5 in total) and images (e.g., each video's thumbnail).

The bottom-most layer is the data layer, where all user-related data is registered in and accessed from – namely, 1) the user's credentials (provided in the initial page's sign up); 2) the amount of times that the user has consumed and saved some content (relayed on the content selection and reproduction pages); 3) the user's sensor and/or self-assessment data (determined in the content reproduction and self-assessment pages); 4) the user's emoJar entries and their respective data (displayed in the emoJar page); and 5) the user's selected emotion representation (reflected in all pages of the system). This data layer is made up by the in-browser local storage, where data is stored within the user's browser in key-value pairs (i.e., a data structure where some text – the "key" – uniquely identifies some data – the "value"; e.g., "Alphabet: [A, B, C, …, X, Y, Z]"). Choosing in-browser local storage over database storage was due to the fact that 1) local storage is natively integrated into web browsers, excusing the use of third-party plug-ins and applications that would only increase the system's complexity and decrease its performance; 2) it is supported by JavaScript, which is the driving force of all of our system's core functionalities; and 3) it is easy to access and register data in it. Its two greatest limitations are the fact that 1) local storage is not secure storage, in that it saves data in unencrypted text form (which is only a problem if two or more users share the same device and one of them wants – and knows – how to find other users' username and password); and 2) all data is permanently lost if the user clears his browser's cache.

Overall, the presentation layer allows the user to interact with the emoJar system (running locally in the user's device, and accessible through its browser). Each action performed by this user is mediated by the business layer and recorded in the data layer. Next, we will discuss the system's data model in order to later discuss how the main features of the emoJar system (described in the previous chapter) were implemented.

5.3 EmoJar System's Data Model

The emoJar system's data model is made up by a total of 7 key-value pairs that essentially keep track of the user's actions, the system's state as a result of those actions, and the user's data. These key-value pairs – 1) "Login data for User X", 2) "User X's views", 3) "User X's saves", 4) "Play selected content", 5) "New emoJar entry", 6) "Current emoJar data for User X", and 7) "Emotion representation at use" – are created at different times and used for different purposes. **Note**: From now on, "X" shall refer to the user's number, which identifies him.

1) "Login data for User X": This key holds the user's login data (username and password), which is created when said user registers himself on the emoJar system through the initial page. This login data is stored in an array (i.e., a set of values in the form of "[Username, Password]") that is accessed by the system whenever the user tries to sign in;

2) "User X views": This key holds the user's "views" data (as in, the amount of times that the user has viewed each of the system's 5 videos), which is created immediately after said user registers himself on the emoJar system. This data is stored in a two-dimensional array (i.e., a set of arrays in the form of "[[Video 1's name, Times viewed], [Video 2's name, Times viewed], …]"), which is then accessed and employed by the system to inform the user, through the content selection and reproduction pages, of how many times a video has been consumed by him;

3) "User X saves": This key holds the user's "saves" data (as in, the amount of times that the user has saved each of the system's 5 videos in his emoJar), which is also created immediately after said user registers himself on the emoJar system. This data is also stored in a two-dimensional array (in the form of "[[Video 1's name, Times saved], [Video 2's name, Times saved], …]"), which is then accessed and employed by the system to inform the user, through the content selection and reproduction pages, of how many times a video has been saved;

4) "Play selected content": This key holds all the data that the system needs to load the user's selected content and its associated information (namely, its title, duration, author, thumbnail, and location – in our work's case, within the "Videos" folder). This data is created immediately before the content reproduction page is loaded, and it is stored in a collection (of the form "[{Data snippet 1: …, Data snippet 2: …, …}]") that includes all the aforementioned details about the selected content;

5) "New emoJar entry": This key holds all the data that the system needs to create a new emoJar entry whenever the user saves and/or comments some content. This data is stored in a collection (of the form "[{Data snippet 1: …, Data snippet 2: …, …}]") that includes the content's author, link, thumbnail, title, duration (when

applicable), date and time of the entry's creation, whether there is sensor/self-assessment data to associate to the entry, and what data this is. Once the saving and/or commenting process is finished, this data is attached to the "Current emoJar data for User X" key;

6) "Current emoJar data for User X": This key holds all data regarding the various emoJar entries that were created by the user. Aside from the inclusion of a unique ID – used only to identify each emoJar entry – data in this key is stored as described for and provided by the "New emoJar entry" key, making for a collection that is shaped like "[{All data for emoJar entry 1}, {All data for emoJar entry 2}, …]";

7) "Emotion representation in use": This key holds some text informing the system of what emotion representation is currently being used. This text (simply "Option 1", "Option 2", or "Option 3") is accessed by the system every time one of its pages loads (barring the initial page), so as to adapt the colors of every emotion-related element to those of the currently selected emotion representation (Figure 5.2).

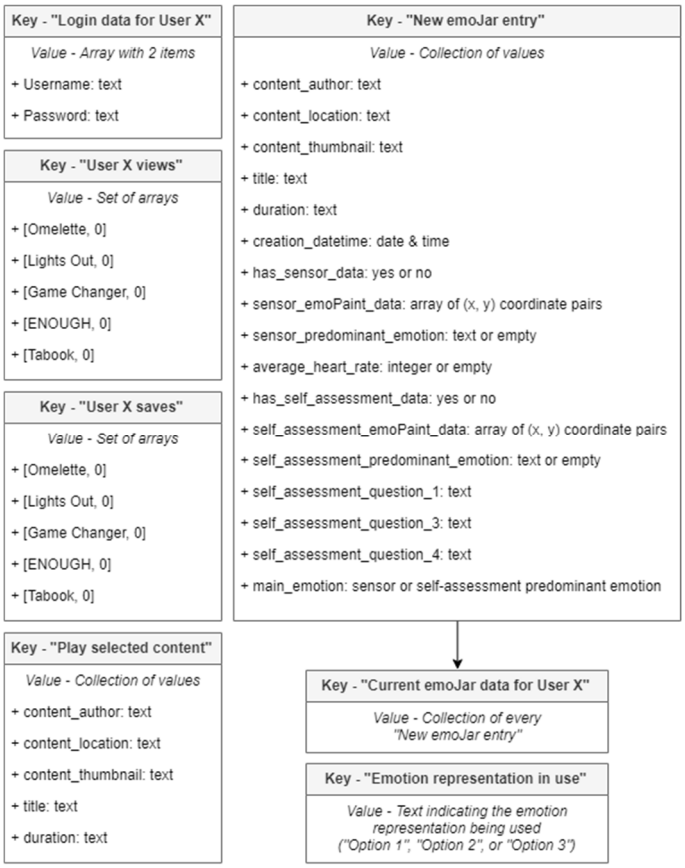

Figure 5.2 – Summary of all key-value pairs that make up the emoJar system's data model.

5.4 Implementation of the emoJar System's Functionalities

In this section, we will go over the implementation of all the emoJar system's functionalities. Since the code that makes up the various functionalities of the system is extensive and somewhat complex, we will resort to the use of pseudo-code to explain how these features were implemented in a detailed yet readable fashion.

5.4.1 Initial page

On this page, individuals register and/or log in to the emoJar system.

To register, individuals must click on the "Sign up" button, which causes a small window to emerge from the current page (courtesy of Bootstrap) with 3 text fields to fill in – one for "Username", and another two for "Password" and "Confirm password" – and a button – called "Sign up" – to complete the registration process. This button is disabled through JavaScript's manipulation of its HTML attributes (namely, the "disabled" attribute) until all text fields are correctly filled in (i.e., the "Username" text field is filled in, and the "Password" and "Confirm password" fields match). Once the "Sign up" button is enabled and clicked, the registration process is finished, and JavaScript commissions the supplied data to the local storage, so that in the future the system knows 1) who has access to it, and 2) who owns the data that it records. This whole process is mediated by the "enableSignUpButton" and "saveUserCredentials" functions, whose pseudo-code is shown below (Figure 5.3).

```
// Invoked every time the device's keyboard is pressed within the 'Sign up' window's text fields
function enableSignUpButton() {
  1. We check if the 'Username', 'Password', and 'Confirm password' fields are empty or filled with spaces...
    1.a. If they are, we disable the 'Sign up' button
    1.b. If they are not...
      2. We check if the 'Password' and 'Confirm password' fields match...
        2.a. If they do, we enable the 'Sign up' button
        2.b. If they do not, we disable the 'Sign up' button
}

// Invoked once the 'Sign up' button is clicked
function saveUserCredentials() {
  1. We find how many registered users there are in the local storage (let's assume there are 'X - 1' users)
  2. We save the individual's credentials in the local storage under the 'Login data for User X' key
  3. Display message informing the individual that he is now a registered user
}
```

Figure 5.3 – The pseudo-code of the "enableSignUpButton" and "saveUserCredentials" functions, that respectively control the process of registering the user in the Media4WellBeing app (and, by extension, the emoJar system), and save his credentials in the emoJar system's data management layer.

To log in, individuals must click on the "Sign in" button. Doing so also causes a small window to emerge from the current page, this one with 2 text fields to fill in – one for "Username", and another for "Password" – and a button – called "Sign in" – to

complete the logging in process. Similarly to the "Sign up" button, the "Sign in" button is disabled through JavaScript's manipulation of its HTML attributes (namely, the "disabled" attribute) until all text fields are correctly filled in. Once the "Sign in" button is enabled and clicked, the local storage is accessed to check if any user with the provided details exists. This entire process is mediated by the "enableSignInButton" and "checkUserCredentials" functions, whose pseudo-code is presented next (Figures 5.4).

```
// Invoked every time the device's keyboard is pressed within the 'Sign in' window's text fields
function enableSignInButton() {
  1. We check if the 'Username', and 'Password' fields are empty or filled with spaces...
    1.a. If they are, we disable the 'Sign in' button
    1.b. If they are not, we enable the 'Sign in' button
}

// Invoked once the 'Sign in' button is clicked
function checkUserCredentials() {
  1. We check in the local storage if there is any registered user with the provided credentials
    1.a. If there is, we inform and move the user to the content selection page
    1.b. If there is not, we display a 'Username or password is invalid' message and do nothing else
}
```

Figure 5.4 – The pseudo-code of the "enableSignInButton" and "checkUserCredentials" functions, that control the process of logging into the Media4WellBeing app (and, by extension, the emoJar system).

5.4.2 Content selection page

On this page, users select the contents they wish to a) consume or b) directly comment on by respectively clicking on these contents' a) thumbnail, title, or "Play" prompt, or b) "Comment" prompt. They can also quickly ascertain how many times the system's contents have been consumed and saved by looking at the "Views" and "Saves" fields, which are filled in by JavaScript after accessing the local storage's "User X views" and "User X saves" keys.

In the "consume" case, users are directed to the content reproduction page, but not before the current page's JavaScript ships all data described and stored in the aforementioned "Play selected content" key to the local storage. This entire process is 1) managed by the "playSelectedContent" function (Figure 5.5), and 2) carried out so that the system knows what content is to be loaded on the content reproduction page.

```
// Invoked when the user clicks on a contents' thumbnail, title, or "Play" prompt
function playSelectedContent(selected content) {
  1. Store the following data about the selected content
     in the local storage under the 'Play selected content' key

       ~ Content info: Author, location, thumbnail, title, and duration

  2. Redirect user to the content reproduction page
}
```

Figure 5.5 – The pseudo-code of the "playSelectedContent" function, responsible for carrying the user and his selected content's data to the content reproduction page.

In the "comment" case, users forsake the content's consumption (which implies that no sensor data is collected) and are directed to the self-assessment page, but to let the system know about what content the following self-assessment refers to, the current page's JavaScript stores some relevant data under the "New emoJar entry" key – data that, with the user's self-assessment, will be further transformed and worked into an emoJar entry. This is achieved by the "commentSelectedContent" function, shown below (Figure 5.6).

```
// Invoked when the user clicks on a content's "Comment" prompt
function commentSelectedContent(selected content) {
  1. Store the following data about the selected content
     in the local storage under the 'New emoJar entry' key

       ~ Content info: Author, location, thumbnail, title, and duration
       ~ Sensor data: None collected, as the user skipped on the content's consumption
       ~ Self-assessment data: None yet, to be provided in the self-assessment page
       ~ Entry's creation date and time: Current date and time
       ~ Entry's predominant emotion: None yet, to be provided in the self-assessment page

  2. Redirect user to the self-assessment page
}
```

Figure 5.6 – The pseudo-code of the "commentSelectedContent" function, responsible for carrying the user and his selected content's data to the self-assessment page.

If users would rather visit their emoJar, they can do so by way of the navigation bar's "emoJar" link, or through the small emoJar icon that is always reflective of its status (in that it boasts the same lid color and entries as the real and upscaled emoJar). Like its bigger counterpart, this icon is made of two SVG rectangles – one for the jar's lid, and another for its shape – which are respectively established and manipulated by this page's HTML (Figure 5.7a) and some JavaScript commands (Figure 5.7b).

```
<!-- We set the emoJar icon we are going to make into a link to the emoJar page -->
  <a link="emojar.html">
    <!-- We create an SVG drawing area that is 100 pixels wide and 50 pixels tall -->
    <svg width="100" height="50" id="emojar-representation">
      <!-- emoJar's lid, a '<rect>' element denoting a rectangle -->
      <rect id="emojar-representation-lid" ... rectangle's attributes (position, size, color, ...)></rect>

      <!-- emoJar's jar shape, also a '<rect>' element denoting a rectangle -->
      <rect id="emojar-representation-jar" ... rectangle's attributes (position, size, color, ...)></rect>
    </svg>
</a>
```

a

```
1. Retrieve the data that makes up all User X's emoJar entries, stored in
   local storage under the 'Current emoJar data for User X' key
2. Determine the currently selected emotion representation, stored in
   local storage under the 'Emotion representation in use' key
3. Set the emoJar lid's color to that of the most present emotion, and in
   accordance with the currently selected emotion representation
4. Use D3 to generate small circles that represent each emoJar entry, and that
   are colored in accordance with the currently selected emotion representation
5. Use D3 to apply small icons representing an entry's associated content type to each circle
```

b

Figure 5.7 – The pseudo-code of the small emoJar representation: in a), the HTML that defines its shape; in b), a description of the steps followed to fill that small emoJar representation with the user's current emoJar entries.

5.4.3 Content reproduction page

In this page, users can consume their selected content (in our case, one of 5 videos that are, on average, 2 minutes and 30 seconds long) and get instant feedback on their experienced emotions and average heart rate.

Before users proceed with their selected content's consumption, JavaScript accesses the "Play selected content", "User X views", and "User X saves" keys on the system's local storage to load 1) the selected content, its title, and its author; and 2) its amount of views and saves, respectively displayed in the "Views" and "Saves" fields.

At this point, it becomes necessary to mention two things – the first is that we were able to turn the camera of the user's computer and/or mobile device into a BVP sensor (even if it is somewhat susceptible to movement and lighting changes), allowing us to measure this user's heart rate and emotional valence (as discussed in section 2.7.1 of this document's Chapter 2); the second is that we decided to emulate the emotion recognition process (to make the system's development more flexible) and, until we can make our improvised BVP sensor less susceptible to movement and lighting changes, we have also decided to emulate the user's average heart rate.

With that out of the way, once users start consuming their selected content, 3 things happen synchronously (that is, apart from updating the page's "Views" field, and the data in the "User X views" key) – 1) this page's "emoPaint" starts being painted, 2) the background and the user's mobile device starts pulsing and vibrating in the way described in the previous chapter, and 3) the average heart rate field starts going up and down as time goes on.

For 1), JavaScript selects a random "emoPaint" quadrant, generates 150 adjacent "(x, y)" coordinate pairs within that quadrant, and paints them as dots. While this happens, an array of integers keeps track of what emotions are being painted and predominantly "felt", reflected in this page's emoJar section; for 2), JavaScript triggers a CSS animation that makes the background pulse, and activates the mobile device's vibration motor to play a short vibration pattern mimicking the user's heartbeat; for 3), JavaScript generates a random heart rate between 60 and 90 beats per minute, which is then incremented, maintained, or decremented randomly. All this is controlled by a function called "drawDot", presented below (Figure 5.8).

```
/* Invoked 5 seconds after the selected content starts playing,
   to give the impression that sensors were booting up */
function drawDot() {
  1. Select an 'emoPaint' quadrant to paint on
  2. Generate 150 adjacent '(x, y)' coordinate pairs (i.e., dots) within that quadrant
  3. Generate a random heart rate between 60 and 90 BPM
  4. Kickstart the CSS animation that makes the background pulse
  5. Start drawing each of the 150 dots (1 per second), and with every drawn dot:
    5.a. Keep track of, and update the predominantly drawn - and thus 'felt' - emotion,
         reflected in the page's emoJar section
    5.b. Increment, maintain, or decrement the heart rate
    5.c. Vibrate the user's mobile device in the aforementioned pattern
  6. Keep doing step 5 until there are no more dots to draw, and finish
}
```

Figure 5.8 – The pseudo-code of the "drawDot" function, responsible for coming up with a sensor-generated "emoPaint", kickstarting the background animation and mobile device's vibration pattern, and updating the "Predominant emotion" text field.

This function also updates the emoJar section's "Predominant emotion" text field and the color of its small circle according to what is drawn in the page's "emoPaint".

By clicking on the emoJar section's "Save" prompt, 1) JavaScript updates the "Saves" field, revises the data under the local storage's "User X saves", and stores the content's basic information and sensor data under the local storage's "New emoJar entry" key; 2) D3 commands the small SVG circle to move inside the emoJar, as if to say that the content and its associated data has been stored in the user's emoJar; and 3) JavaScript turns the "Save" prompt into a "Remove" prompt (which undoes the previous and following steps), and creates a "Comment" prompt. If, at this point, the user decides to leave the content reproduction page, all data under the "New emoJar entry" key is appended to the "Current emoJar data for User X" key. If, instead, they would rather provide their self-assessment about the consumed content, they may do so by clicking on the "Comment" prompt, directing them to the self-assessment page.

5.4.4 Self-assessment page

When this page loads, JavaScript accesses the local storage's "New emoJar entry" key to 1) load the consumed content, which the user can replay for a more complete assessment; and 2) recreate the sensor-generated "emoPaint" and load the user's average heart rate value (assuming that sensors were employed, of course).

The process by which JavaScript recreates the sensor-generated "emoPaint" is simple: just like in the previous page, two images lay on top of each other – the background image is one where a color wheel (whose colors depend on the emotion representation being used) lays on top of two axes (one for valence and another for

arousal); the foreground image is one with just the valence and arousal axes. JavaScript then fetches these 150 "(x, y)" coordinate pairs (generated in the previous page and stored under the "New emoJar entry" key) and turns the foreground image's opacity to "0" in each point. This very same process is employed whenever it becomes necessary to recreate an "emoPaint" (e.g., in the emoJar page), regardless of whether it was generated by sensors or users.

After all this is done, users are asked to 1) rate how much they agree with the recognized emotions through one of 7 buttons, of which the last one – the "Strongly agree" button – causes the sensor-generated "emoPaint" to be replicated in the following question's drawing area; 2) draw their own "emoPaint" by having JavaScript make the drawing area's foreground transparent in the places where the user's mouse pointer or finger has been dragged, revealing color underneath; 3) elaborate on why they have felt said emotions through a text field; and 4) elaborate on what made the consumed content memorable, also through a text field. As soon as all 4 questions are answered, the page's "Finish" button is enabled by JavaScript, and eventually clicked by the user, which makes JavaScript rush to append all data under the "New emoJar entry" key – now complete with self-assessment data – to the "Current emoJar data for User X" one before redirecting the user to the emoJar page.

5.4.5 EmoJar page

When this page loads, the user's emoJar slides in from the left (courtesy of the previously mentioned Animate.css library). Like its smaller counterpart, the emoJar is made out of two SVG rectangles – one being for the jar's lid, and another one being for its shape – that are respectively set up and manipulated by the page's HTML and JavaScript. The process by which the emoJar's lid color and entries are generated is also akin to that of its petite version: first, JavaScript collects the data under the local storage's "Current emoJar data for User X" key, and then it accesses the "Emotion representation in use" key to know what colors it should apply to the emoJar's lid and entries – which are generated by D3 using the data from the "Current emoJar data for User X" key. What ultimately differentiates the little emoJar from the one presented in this page is the fact that the latter can – among other things – be filtered to find entries with certain characteristics.

To filter the emoJar and its entries, users have to "open" the "Filters" section, which is kept hidden by this page's HTML and CSS until users click on the "Filters" button. From there, users can combinatorially access and select all filters that were mentioned in the previous chapter. Each kind of filter is associated with an appropriately named array (e.g., "selected_emotion_filters", where the user's selected emotion filters are stored as text such as "Happiness" and/or "Ecstasy"), and each array is accessed by JavaScript upon clicking on the "Filters" section's "Apply" button to find entries that meet the desired characteristics (e.g., "entries created between the 2nd and 5th of February, whose videos made me feel happy and enthusiastic"). This filtering process is taken care of by a function called "filterEmoJarEntries", that operates as following (Figure 5.9).

```
/* Each filter's associated array, which are manipulated by other functions
   as a result of the user's actions, selections, and deselections

   The following values are just exemplary */

var search_term_filter = [];
var selected_type_filters = ['Video', 'Audio'];
var selected_emotion_filters = ['Happiness'];
var selected_sensor_data_filter = ['With'];
var selected_self_assessment_data_filter = ['With'];
var selected_date_filter = [];
var selected_heart_rate_filter = [];
var selected_content_consumptions = [];

// Invoked whenever the user clicks on the "Apply (filters)" button
function filterEmoJarEntries() {
  1. Retrieve all data stored in the 'Current emoJar data for User X' key,
     which concerns all emoJar entries to date
  2. For each filter's associated array, and until there are no more arrays to go through:
    2.a. Check if it is storing any values
      2.a.1 If it is, go through each (remaining) emoJar entry and only keep those that
            match the selected filter
      2.a.2 If it is not, skip to the next filter array
  3. Have D3 render the resulting entries
}
```

Figure 5.9 – The pseudo-code of the entire filtering process.

Having to a) click on an "Apply" button to apply all selected filters and get one's desired entries instead of b) having the emoJar update its entries with each selected filter (i.e., in real-time) was due to our unfamiliarity with the D3 library (which is used to render every emoJar entry) at the beginning of this system's development. At the time of this document's writing, we are confident that – with time – we could rebuild the filtering process to work in real-time, as we are now sufficiently at home with D3. That being said, through our system's user evaluation, we concluded that most users prefer

things to work the way they currently do (i.e., they prefer to select filters and get all desired entries only after applying them).

Most filters are relatively simple to select, asking users to do little more than to click on a checkbox or manually fill in a small text field. An exception to this rule is the "Heart rate" filter, where we feature two novelty mechanisms that allow users to estimate and employ their own heart rate to find entries where the average heart rate at the time of the associated content's consumption was the one currently detected.

The first of these two mechanisms works by having users simply 1) press their carotid artery with their fingertips, and 2) tap a heart icon to the frequency of their heartbeat (just once per heartbeat though, as feeling the two thumps of one's heart can be challenging, and tapping the heart icon to replicate this thump-thump pattern even more so) for a total of 10 seconds. Below is a description of how the user's heart rate is estimated with this mechanism (Figure 5.10).

```
// Several functions work together to do the following

var secondsPassed = 0.0;
var tapCount = 0;

1. Once the heart icon is tapped for the first time:
  1.a. Start to keep track of the elapsed time through the 'secondsPassed' variable
  1.b. Count the first tap by incrementing the 'tapCount' variable
2. With each subsequent tap:
  2.a. Make the heart icon pulse
  2.b. Multiply the number of taps by 55 (e.g., 8 taps * 55 = 440)
  2.c. Divide the value obtained in 2.a. by the amount of 'secondsPassed' (e.g., 440 / 5.5 seconds = 80)
  2.d. Round this value to its nearest integer
  2.e. Inform the user of his estimated heart rate by updating the heart rate slider's position,
       the heart icon's color to that of the slider, and finally the heart rate text field
3. Keep doing step 2 until 10 seconds have elapsed
```

Figure 5.10 – The pseudo-code of the process by which, through the tapping mechanism, the user's heart rate is estimated.

Throughout this mechanism's development, we have employed the use of a wrist-based blood pressure and heart rate monitor (url-Sanitas) to check if the estimated heart rate was accurate. The process of estimating the user's heart rate through this mechanism does not take more than 10 seconds because we realized that, by the end of approximately 7 seconds, the user's estimated heart rate had already stabilized. Through trial and error, we have also found that multiplying the number of taps by 55 and dividing the resulting value by the number of elapsed seconds gave us an estimated heart rate value that closely matched that of our blood pressure and heart rate monitor.

The second of these two mechanisms makes use of the device's camera to automatically estimate the user's heart rate. Once users click on the "Auto-detect" button, an SVG canvas shows up underneath it, hosting 1) a small circle with the camera's video stream on the left, 2) a heart rate line graph on the right, and under both

3) a prompt for users to place a finger on the camera of their computer or mobile device for a total of 30 seconds. Then, the mechanism's algorithm starts measuring changes in the light intake of the device's image sensor, which is affected by the volume of blood passing through the user's finger with each heartbeat. Below is a concise description of how the user's heart rate is estimated through this mechanism (Figure 5.11).

```
var secondsPassed = 0.0;
var beatCount = 0;

1. Upon clicking on the 'Auto-detect' button, ask for the user's consent
   to use the device's camera
  1.a. If the user consents, go to step 2
  1.b. If the user does not consent, finish
2. Reveal the SVG canvas, where:
  2.a. An SVG circle is to show the camera's video stream, so users know
       if they're covering the camera correctly
  2.b. A dynamic heart rate line graph is to be rendered throughout the
       heart rate's estimation
  2.c. An SVG prompt is to tell the user 1) to place his finger on the device's
       camera, and 2) how much time is left until the estimation is complete
3. Quickly process every video frame to establish an average brightness value
4. Once an average brightness value is established, consider the following:

  ~ Every heart beat pushes blood to the tip of the user's finger,
    causing a less than average amount of light to reach the device's camera.
    This light change happens rhythmically, so the principle of the tapping
    mechanism can be applied here. That being said:

    4.a. Start to keep track of the elapsed time through the 'secondsPassed' variable
    4.b. Every time the camera receives less than the average amount of light
         (determined in step 3), increment the 'beatCount' variable
    4.c. Multiply the number of beats by 55 (e.g., 8 beats * 55 = 440)
    4.d. Divide the value obtained in 4.c. by the amount of 'secondsPassed' (e.g., 440 / 5.5 seconds = 80)
    4.e. Round this value to its nearest integer
    4.f. Inform the user of his estimated heart rate by updating the heart rate slider's position,
         the heart icon's color to that of the slider, and finally the heart rate text field
5.a If this process is undisturbed, keep doing step 4 until the total of 30 seconds has elapsed
5.b If this process is disturbed, reset the 'secondsPassed' and 'beatCount' variables and go back to step 3
```

Figure 5.11 – The pseudo-code of the process by which, through the camera of one's device (computer or mobile device), the user's heart rate is estimated.

As mentioned previously, this mechanism is somewhat susceptible to movement and lighting changes which disturb the estimation process and, consequently, might frustrate users once the mechanism's novelty wears off. In the future, we will try to attenuate this improvised BVP sensor's susceptibilities and, as previously mentioned, try to use it for emotion recognition.

In the previous chapter, the possibility of extracting a random emoJar entry by shaking one's mobile device was mentioned. To achieve this, it was necessary to create some JavaScript code that would continuously 1) access the accelerometer data of the user's mobile device, 2) study said data to determine the mobile device's current acceleration along its X and Y axes, and 3) simulate a click of the page's "Random" button (which has all the "extract a random entry" logic associated to it) whenever the values associated to these two axes were in a given range (Figure 5.12).

```
// Only for mobile devices

1. Continuously access and study the mobile device's accelerometer data
  1.a. If the mobile device's current acceleration along its X (horizontal) axis
       is between 15 and 20 meters per second squared, go to step 1.b.
  1.b. If the mobile device's current acceleration along its Y (vertical) axis
       is between -5 and 10 meters per second squared, go to step 2
2. Lightly vibrate the mobile device, and programatically click on the 'Random' button

// Clicking on the random button does the following

1. Vertically extend the emoJar's SVG
2. Randomly select one of the emoJar's small circles, and smoothly translate it into
   the empty space that resulted from doing step 1

P.S.: If an entry is outside the emoJar and users click on the 'Random' button or shake
      their mobile device, these two steps are undone, returning the entry to its original place
```

Figure 5.12 – The pseudo-code of the process by which, by shaking one's device, a random emoJar entry is extracted.

When we thought about shaking a real jar, we thought about shuffling its contents, which is to say that shaking one's mobile device to extract a random emoJar entry was not the gesture we originally planned to implement. Initially, we wanted to have users rotate their mobile devices as if they were pouring an entry out, but for some reason – most likely, a logic flaw in our code – we were unsuccessful in making that happen, with our mobile device's accelerometer simply registering a sudden change in its orientation and, consequently, making the emoJar system's interface switch from portrait (i.e., vertical) to landscape (i.e., horizontal) mode. Since we could not find a way around this issue, we started to consider a shaking gesture as the solution to our problem, and so, through trial and error, we managed to eventually create a shaking gesture that 1) we believe to be quick and easy to do and remember, and 2) would not cause the unintentional triggering of a random emoJar entry's extraction every time the user moved his device (which was a problem at first).

5.5 EmoJar System's Implementation Metrics

To put the size and effort made towards the development of the emoJar system into perspective, a table with the number of lines of code (LOC) is presented below.

Table 5.1 – EmoJar system's amount of written code.

Language	Files	Blank lines	Comment lines	Lines of code
HTML	5	480	364	1804
CSS	5	646	371	1554
JavaScript	5	1730	1759	9108
Total	15	2856	2494	12466

All code was written from scratch, because we wanted to create a system that could be used on mobile devices, and leverage some of these devices' features.

Since code, in itself, is not self-documenting, we took the time to comment every HTML, CSS, and JavaScript file that makes up our system, so that anyone (including our future selves) who might have to maintain, refactor, or extend our code knows what all its components do.

5.6 Summary

Throughout this chapter, all aspects concerning the emoJar system's implementation were discussed. Through a select set of 2 tools and 12 web technologies, we ended up with a 5-page system that consists of 3 distinct but closely related layers, one being responsible for the system's contents and styling (i.e., presentation layer), and the other two for its behavior and data management (i.e., business and data layer, respectively). A high-level description of how each page's features and functionalities were implemented was also provided, detailing the challenges that we faced, the solutions that were found, and the system's overall limitations. What follows is a presentation of the results of this system's user evaluation.

Chapter 6

EmoJar System's User Evaluation

This chapter presents the objectives, context, methodology, participants, and results of the emoJar system's user evaluation.

6.1 Objectives

The primary objective of this user evaluation was to assess the emoJar system and its functionalities' perceived usefulness, satisfaction, and ease of use. Also, we wanted the users' opinions, comments, and suggestions on the system's interface, features, and employed representations.

6.2 Methodology

The conducted evaluation – which was supported by the guide found in this document's Annex – consisted of 1) semi-structured interviews, and 2) user observation while they carried out previously defined tasks.

First, the evaluation and system's purpose were disclosed, and a selection of demographic questions were asked. Following this, users were asked to perform the previously defined set of tasks (shown in Table 6.1), and to answer the interview's questions.

Table 6.1 – Evaluation's set of tasks.

Task #	Task
1	Gauge the emoJar's state without leaving the content selection page.
2	Select, consume, and save the video "Omelette".
3	Comment on the consumed video.

4	Review the emoJar entry that was created as a result of consuming, saving, and commenting the selected video.
5	Change the emotion representation at use.
6	Extract a random entry from the emoJar.
7.1	Find specific emoJar entries, part 1.
7.2	Find specific emoJar entries, part 2.
7.3	Find specific emoJar entries, part 3.
8	Get an overview of one's emoJar use.

For each task, we 1) observed and noted users' completion speed, errors and hesitations; 2) asked users to rate the perceived usefulness, satisfaction, and ease of use (USE, (Lund, 2001)) of these tasks' functionalities and representations on a 5-point scale; and 3) gathered qualitative feedback in the form of users' comments and suggestions. All tasks were executed on a camera-equipped laptop. At the end of each task, users were asked to interact with the system on a smartphone, to make it possible for us to 1) determine if the difference between a large and a small screen's interface layout somehow prevented users from executing a given action or task; and to 2) get feedback on some of our system's mobile-exclusive features (namely, the vibration on the content reproduction page, and the "shake to extract a random entry" command on the emoJar page).

In the end, users were asked to 1) make an overall assessment of the system in terms of its design, usefulness, satisfaction, ease of use, and usability (SUS, (Brooke, 1996)); 2) mention the features and characteristics that positively stood out to them; 3) make their final comments and suggestions on what they would like to see improved or added in the future; and 4) characterize the system by selecting pre-defined terms that adequately reflect its appeal and overall ergonomic and hedonic qualities (Hassenzahl et al., 2000).

6.3 Participants

This evaluation was conducted with 10 participants – 5 male and 5 female – aged between 22 and 57 (average 31.1, standard deviation 12.6), all with higher education (1 with a doctoral degree, 3 with a master's degree, 6 with a bachelor's degree), coming

from different backgrounds (1 system's engineer, 1 telecommunications engineer, 1 electrical engineer, 1 secondary education teacher, 1 human resources manager, 1 multimedia designer, and 4 Information Technology college graduates pursuing their master's degree in Informatics), moderate to high levels of digital literacy, and having their first contact with the emoJar system. What follows is a summarized review of what participants had to say on the subject of 1) digital content's impact, 2) means and platforms by which they access digital content, 3) what drives their digital content consumption, 4) how and why they save digital content, and 5) whether they had ever heard of and used a Happiness Jar, related applications, and physiological sensors. **Note**: From this point forward, an average will be referred to as "Avg", and a standard deviation will be referred to as "Std".

1) Digital content's impact: Using a scale of 1 to 5 (where 1 means "Strongly disagree" and 5 means "Strongly agree"), all 10 participants strongly agreed that digital content can make an individual experience emotions (Avg: 5, Std: 0), has the ability to evoke memories (Avg: 5, Std: 0), and that it can make an individual experience emotions as a result of having evoked memories (Avg: 5, Std: 0).

2) Means and platforms by which digital content is accessed: To access digital content, these 10 participants make use of their computer (2 every day, 4 more than once per week, 2 just once per week, and 2 sporadically), smartphone (10 every day), and tablet (2 sporadically) devices. The platforms accessed by these participants to consume digital content are YouTube (5 every day, 3 more than once per week, and 2 sporadically), Netflix (4 every day, 3 more than once per week, and 2 sporadically), Spotify (2 every day, 6 more than once per week), Instagram (4 every day), Pinterest (2 more than once per week, and 2 sporadically), Vimeo (4 sporadically), TED.com (3 sporadically), Crunchyroll (1 more than once per week), and Flickr (1 sporadically).

3) What drives digital content consumption: Through a 1 to 5 scale (where 1 means "Strongly disagree" and 5 means "Strongly agree"), we have found that participants consume digital content to a) feel more relaxed (Avg: 4.2, Std: 0.6), b) be entertained (Avg: 4.8, Std: 0.4), c) feel good (Avg: 3.4, Std: 0.5), d) feel more creative (Avg: 2.3, Std: 1.2), e) feel motivated (Avg: 2.9, Std: 1.1), f) be able to deal with

difficult situations (Avg: 2.9, Std: 1.1), g) be informed (Avg: 3.5, Std: 0.5), h) be able to improve as a person (Avg: 2.3, Std: 1.2), i) be able to work better (Avg: 2.2, Std: 1.3), j) positively influence others (Avg: 1.3, Std: 0.5), k) feel better about themselves (Avg: 2.6, Std: 1.1), l) better know themselves (Avg: 1.6, Std: 0.7).

4) How and why digital content is saved: When asked about how they save digital content, 5 participants said they download and store digital content on their computer (3) and smartphone (2) devices, 9 said they save them on their browser's favorites, and 6 said they save them in a playlist of the platform where digital content is consumed (e.g., YouTube, Spotify). By way of a 1 to 5 scale (where 1 means "Strongly disagree" and 5 means "Strongly agree"), our 10 participants said they save digital content a) to consume it later on (Avg: 4.1, Std: 0.3), b) to reminisce about it later on (Avg: 1.5, Std: 0.7), c) to share it with others later on (Avg: 3.2, Std: 0.9), d) because it symbolizes a moment of their lives (Avg: 3, Std: 0.9), e) to form a collection of digital content that they enjoy (Avg: 4.4, Std: 0.5), and/or f) to later change their mood (Avg: 2.4, Std: 0.9).

5) Happiness Jar, related apps, and physiological sensors: At this point, we wanted to know the means by which our participants recorded and described their lives' most memorable moments, as well as these moments' associated thoughts and emotions. Of our 10 participants, we have found that 6 do so on social media platforms (5), their diary (3), their smartphones' default note-taking apps (2), and on the back of Polaroid photographs (1). The remaining 4 participants are not in the habit of recording and describing the memorable moments of their lives, nor the thoughts and emotions resulting from those moments.

After this, we asked our participants 1) if they were familiar with the Happiness Jar concept before we introduced them to it, 2) if they had ever created and used an Happiness Jar, and 3) if they had ever used an app or platform that was based on, or related to the concept of Happiness Jar – all of them (10) answered "No" to these 3 questions.

Finally, we looked at whether these 10 participants had previous experience with physiological sensors, and we found that 4 of them did – 2 in an academic context

(EEG, ECG, and BVP sensors), and another 2 for personal use (at-home ECG sensors). The remaining 6 had never used physiological sensors but were interested in doing so.

6.4 Results

In this section, we present our evaluation's results. Overall, we can say that users have completed all tasks quickly and without much hesitation, and that they generally enjoyed their time and experience with the system. **Note**: From now on, we will respectively refer to "Usefulness", "Satisfaction", and "Ease of Use" by the letters "U", "S", and "E".

6.4.1 Content selection page

On this page, we asked users to perform **Task 1** (i.e., "Gauge the emoJar's state without leaving the content selection page.") to determine if they would notice the small emoJar representation to the right of this page's tabs, and if they could use it to correctly assess their emoJar's state (empty at the time of this task).

Out of 10 users, 6 were able to quickly find and make use of the small emoJar representation to correctly assess that their emoJar was empty. The remaining 4 took some time to find this representation, but as soon as they did, they easily determined that their emoJar was empty. These 4 users attributed their delay to the representation's lack of prominence, with the addition of a small identifying text being pointed out as a solution (which we readily adopted).

Overall, this feature's USE results were (U: 4.1, S: 4.0, E: 5.0). By the end of Tasks 4 and 5 (when users already have an entrance in their emoJar, and have just changed the emotion representation at use), we allowed users to see how this small emoJar representation changed as a result of their actions, with some of them finding this feature "useful", "delightful", and "amusing".

6.4.2 Content reproduction page

On this page, we asked users to perform **Task 2** (i.e., "Select, consume, and save the video 'Omelette'."). Since (Bernardino, 2018) had already studied what users thought of the "emoPaint" view, with this task we sought only to understand what users thought about the features we had recently introduced, namely:

1) having the interface's background pulse to the rhythm of one's heartbeat (U: 3.3, S: 3.3, E: 4.1), a feature that 3 users would rather see "on" (as it let them know that their heart rate was being estimated), 2 users would rather see "off" (as they found it distracting), and 5 users were "indifferent" towards (as they found it subtle enough to go unnoticed when focusing on their selected content);

2) feeling one's heartbeat through the smartphone while consuming the selected content (U: 3.5, S: 3.8, E: 5.0), a feature that 3 users would rather see "on" (because they found it "uniquely different" and "a very real way of communicating one's heart rate"), 2 users would rather see "off" (as they found it distracting and "potentially irritating" in the long-term), and 5 users were "indifferent" towards (as they found it subtle enough to not disturb and to go unnoticed after a while);

3) having the "emoPaint" be painted to the rhythm of one's heartbeat (U: 3.5, S: 3.4, E: 4.0), which 3 users found "curious" and "interesting", and 1 felt that, if not for the smartphone's vibration that goes along with the painting of a dot, this feature could go a little "unnoticed";

4) having a "Average heart rate" text field showing one's average heart rate in real-time (U: 3.8, S: 3.8, E: 5.0), which most users thought to be "interesting" and "informative", as it made them more acquainted with how their bodies responded to digital content that they found to be emotionally uplifting, sad, or even scary. After doing Task 7.2, one user mentioned that it would be interesting to have a heart rate line graph showing how one's heart rate changes along some content's consumption;

5) having a "Predominant emotion" text field showing one's predominantly felt emotion (U: 4.8, S: 4.5, E: 5.0), which all users appreciated, and some believed to be "absolutely essential" to understand what emotion was truly predominant when the generated "emoPaint" had two or more identically painted emotions;

6) being able to save the consumed content on one's emoJar (U: 4.1, S: 4.1, E: 4.5), which users acknowledged as being easy to do and communicated clearly (i.e., it

was easy to know and understand when the consumed content had been saved and when it had not).

6.4.3 Self-assessment page

On this page, we asked users to execute **Task 3** (i.e., "Comment on the consumed video.") to get their input on some of this page's features, like:

1) the ability to rate how much they agree with the sensor-recognized emotions (U: 5.0, S: 4.4, E: 5.0), which users found "convenient", as they sometimes disagreed with the generated results, or thought that the sensors had failed to recognize a particular emotion. One of the users suggested the use of machine learning to make for more precise sensor-generated results;

2) the ability to draw their own "emoPaint" (U: 5.0, S: 5.0, E: 5.0), which users found to be an "original" and "inventive" way of providing their personal perspective on what emotions they have experienced throughout their selected content's consumption.

A flaw of this feature – which we struggled and ultimately failed to correct within the allotted development time, as trivial as it might possibly sound – is the fact that it is not possible to "Undo" any potential mistakes in one's drawing, only "Reset" the whole thing and draw it anew. Curiously, none of our 10 users complained about this limitation, as they simply tested the act of drawing, clicked on the "Reset" button, and followed that up by drawing their "emoPaint" as they believed to best describe their experienced emotions. When alerted to this flaw, some users said they did not think it would be hard to replicate a drawing they had reset due to a mistake, but all of them recognized the usefulness of having a "Undo" and a "Redo" button.

Two users appreciated the fact that strongly agreeing with the sensor-generated "emoPaint" caused it to be automatically replicated in their own "emoPaint" drawing area, excusing them of trying to match the sensor-generated one. One user mentioned that, to quickly complete one's self-assessment, it would be useful to have buttons as an alternative way of pointing out one's felt emotions, but upon further discussion, this same user recognized that his suggested input method would not be as interesting as the one currently employed. In this discussion, it was abundantly clear that one of our

system's greatest limitations would have to be addressed in the future, which is the fact that a user's self-assessment cannot be delayed or even edited at a later date, meaning that users either complete their self-assessment once they start it, or the entry that was previously created in their emoJar is left without it.

Overall, being able to provide one's self-assessment about the consumed content was seen as (U: 5.0, S: 4.3, E: 5.0). When asked about the relevance and volume of the self-assessment's questions, all users felt that our questions were relevant (relevance being measured on a 1 to 5 scale where 1 means "Completely irrelevant" and 5 means "Completely relevant"; Avg: 5.0, Std: 0.0) and in the right amount (i.e., 4), with some of them stating that more questions would make the self-assessment process "tedious" and "laborious", and that less questions would not allow them to properly explain what made the consumed content worth saving in their emoJar.

6.4.4 EmoJar page

On this page, we asked users to execute all remaining tasks (i.e., Task 4 through 8). **Note**: For Task 4 and 5, all users had in their emoJar was the entry that resulted from doing all previous tasks, but from Task 6 forward, they would have 13 entries to test other features with.

Through **Task 4** (i.e., "Review the emoJar entry that was created as a result of consuming, saving, and commenting the selected video."), we managed to get the users' feedback on:

1) how easy (on a 1 to 5 scale where 1 means "Very hard" and 5 means "Very easy") it was to understand that their first emoJar entry a) concerned a video (Avg: 5.0, Std: 0.0) and b) had as its predominant emotion that which had been provided in their self-assessment (Avg: 5.0, Std: 0.0), all of this just by looking at said entry;

2) the emoJar entry's preview (U: 5.0, S: 4.3, E: 4.4), which all of them found "convenient", as it allowed them to know a) what content some entry was about, and b) what information about that content's consumption said entry might contain. On the computer, all 10 users found that accessing their emoJar entry's preview was trivial, as

it required no more than putting the mouse pointer over said entry. On the smartphone, 4 users did not know what to do and had to ask for help – after telling them to go through the emoJar's instructions (where it is made clear that previewing an entry on one's smartphone can be achieved by long pressing it), these users managed to access their entry's preview. The remaining 6 users succeeded in accessing their entry's preview. When asked to elaborate on their thought process, 4 of these users said that it simply occurred to them to long press the entry, and the remaining 2 said they thought about how on Android and iOS smartphones one can access contextual menus by long pressing an app's icon. After having all users review their emoJar entry, we asked them if an entry's preview had to much information in it, to which they all said it had just the right amount;

3) the ability to review an emoJar entry (U: 5.0, S: 4.5, E: 5.0), which users found to be instrumental in understanding what made their consumed contents memorable and ultimately worth saving. All 10 users thought that their entry's information was well sorted (Avg: 4.5 and Std: 0.5 on a 1 to 5 scale where 1 means "Very poorly sorted" and 5 means "Very well sorted"), but 4 mentioned that they would like to have the sensor and user-generated "emoPaint" side by side. This was not possible because the amount of horizontal space we had to work with on smartphones (one of our target devices) was quite limited, and would make both "emoPaint" become very small when arranged in the way mentioned by these 4 users;

4) the ability to directly access the content that the emoJar entry is about (U: 4.3, S: 4.0, E: 4.5), which users considered to be a nice shortcut to searching for that content on the content selection page, and a quick way of replaying content that they found memorable.

Through **Task 5** (i.e., "Change the emotion representation at use."), we asked users to do what the task implies, and see how changing the emotion representation at use reflected on their previously created entry and both its "emoPaint". In that process, we collected the users' feedback on:

1) the multicolored icon that illustrates the currently selected emotion representation (U: 4.1, S: 3.9, E: 5.0), which users found “handy” as it quickly informed them of the emotion representation at use;

2) the ability to select another emotion representation (U: 4.4, S: 4.8, E: 5.0), which all 10 users appreciated. After selecting one of our 3 available emotion representations, 6 users stated that their choice was driven by their personal preference towards the selected representation’s colors, 2 stated that they felt the selected representation’s colors to be more representative of the emotions used in our system, and the remaining 2 said it was due to a mix of both of the above reasons. Most users thought that the window where all emotion representations are presented should better highlight the one that is currently being used, with the addition of small indicative arrows or some identifying text being suggested (we adopted the latter);

3) being able to, in the future, a) create their own emotion representation, with their own colors (8 users said they would like to be able to do it; 2 said they did not have much interest in being able to do it, as they thought they were well served with the 3 emotion representations we offered), and b) customize their emoJar (4 users said they would like to be able to change its name, give its lid a checkered or striped pattern, and turn its entries into emojis or make them heart-shaped); 6 said they did not have much interest in being able to do it, as they liked it in its current, unadorned form).

From **Task 6** onwards, the users’ emoJar had 13 entries. Before having users execute the task at hand (which was to “Extract a random entry from the emoJar.”), we asked them to identify the emoJar’s most present emotion and tell us how they came to their reached conclusion. All 10 users correctly identified “Happiness” as the emoJar’s most present emotion, coming to that conclusion through the emoJar’s lid (10) and, additionally, by checking that there were more entries with the color of the emoJar’s lid than there were more entries of any other color.

After this, users went through with the task. On both the computer and smartphone, all 10 users made quick use of the “Random” button to extract a random emoJar entry (U: 4.5, S: 4.5, E: 5.0), which also meant that it did not occur to any user – not even those who had previously read the instructions – that they could shake the

smartphone to the same effect. Having read the instructions and obtained a random emoJar entry by shaking the smartphone, most users commented that the existence of an always accessible "Random" button just below the emoJar made the "shake to extract a random entry" command "somewhat redundant", as they believed that it would always be faster and easier to click on said button instead of shaking the smartphone. That being said, users found this feature interesting and distinctive (U: 2.7, S: 3.4, E: 3.6).

In **Task 7.1** (i.e., "Find specific emoJar entries, part 1."), we asked users to find emoJar entries whose associated content was a video called "Tabook" that had made them predominantly experience "Surprise". To that end, all users accessed the "Filters" section, and from it they selected and filled in the appropriate filters. Once that was done, users clicked on the "Apply" button, and thus they concluded this task. We then took the opportunity to ask them about:

1) the ability and process of filtering the emoJar's entries by their associated content's a) type (in this case, video) (U: 5.0, S: 3.6, E: 5.0), b) title or author (in this case, the title "Tabook") (U: 5.0, S: 3.5, E: 5.0), and c) predominantly felt emotion (in this case, "Surprise") (U: 5.0, S: 4.1, E: 5.0);

2) having to click on an "Apply" button to apply all selected filters and get one's desired entries as opposed to having the emoJar update its entries with each selected filter (i.e., in real-time). Of our 10 users, 5 prefer the filtering process to work the way it currently does (i.e., getting one's desired results after selecting and then applying filters), because they dislike the idea of a real-time alternative where filters are applied and results are presented without the user's go-ahead (1), or find that it would be too distracting or confusing to have the emoJar change every time a filter was selected or deselected (4); 2 would prefer the filtering process to work in real-time, with results being presented as filters are selected, as it is what they are accustomed to; and 3 do not have a preference;

3) the emotion arrangement they used to select "Surprise" – 7 users employed the wheel of emotions (6 because it was selected by default, and 1 because the wheel was this user's favorite emotion arrangement), and the remaining 3 used the alphabetically

ordered buttons (because they preferred buttons and the fact that they were alphabetically sorted, which allowed them to quickly find their desired emotion);

4) the small tooltips that pop up when a filter region is closed with filters active (U: 5.0, S: 4.6, E: 5.0), a detail that users found to be "very thoughtful" and useful.

In **Task 7.2** (i.e., "Find specific emoJar entries, part 2."), we asked users to find emoJar entries that contained sensor data, were created between two provided dates, and had the user's present heart rate (with a tolerance of 40 beats per minute) as its average heart rate. Once that was done, we wanted the users' feedback on:

1) the ability and process of filtering the emoJar's entries by a) whether or not they contain sensor and/or self-assessment data (U: 5.0, S: 3.3, E: 4.6), b) the date or date interval in which these entries were created (in this case, between and including the 5th and 7th of June, 2019) (U: 5.0, S: 3.5, E: 5.0), and c) the user's average heart rate at the time of the associated content's consumption (U: 5.0, S: 4.7, E: 4.5);

2) using the device's camera and a finger to estimate one's heart rate (U: 5.0, S: 4.4, E: 3.5), which users found "unique" and "very interesting", even if it turned out to be "somewhat frustrating" to use due to its slight sensitivity to changes in lighting and finger placement. Out of our 10 users, only 4 managed to get an estimate of their heart rate, of which 3 required more than one try. Whether or not they were able to get an estimate of their heart rate through this method, all users were asked to use the tapping mechanism;

3) using the tapping mechanism to estimate one's heart rate (U: 5.0, S: 4.6, E: 4.6), which users found "fun" and "original". Of our 10 users, a) the 4 who had managed to obtain an estimate of their heart rate with the previous mechanism were pleased to see that the tapping mechanism presented them with a very similar estimate; and b) 1 user mistakenly tapped this mechanism's heart icon twice with each heartbeat, as he could easily feel the heart's contraction and relaxation, and because he thought he was supposed to tap with each pulsation he felt – we then told this user that it was only one tap with each heartbeat because it can be challenging to feel the two thumps of

one's heart (as proven with the other 9 users), and because we believed that tapping the heart icon to replicate this thump-thump pattern could prove to be even more challenging (as proven with, and felt by this user);

In **Task 7.3** (i.e., "Find specific emoJar entries, part 3."), we asked users to find the first emoJar entries that were created about every single saved content, and to find all emoJar entries about every repeatedly saved content. Once this task was completed, we asked for the users' input on:

1) the ability and process of a) finding the first emoJar entries that were created about every saved content (U: 4.6, S: 4.6, E: 5.0), and b) finding all repeated entries about every saved content (U: 4.7, S: 4.4, E: 5.0), with users considering the latter especially useful for comparing how they felt upon subsequent consumptions of the same content;

2) how well they understood the views in which these first and repeated entries are presented, something that was determined by way of 3 questions that essentially ask users to put a number on the amount of entries – out of a total of 13 – that correspond to a) the first time some content was saved in the emoJar (10 out of 13 entries, with all 10 users answering correctly), b) content that was repeatedly saved (5 out of 13 entries, with all 10 users answering correctly), and c) repeated saves of the video "Omelette" (2 out of 13 entries, with all 10 users answering correctly).

Finally, in **Task 8** (i.e., "Get an overview of one's emoJar use."), we had users accessing the "Overview" perspective and feeding us 9 bits of information regarding 1) how many times "Happiness" had been predominantly felt, according to the system's sensors and the user's self-assessment; 2) how many entries concerned videos, audio, images, and text quotes; 3) how many entries have sensor data, and how many have self-assessment data; 4) the distribution of predominantly felt emotions recognized by the sensors and by the user's self-assessment throughout all emoJar entries; 5) the percentage of times that the user has "Agreed" with the sensor's results; 6) the average number of words written with each provided self-assessment; 7) the date of the first emoJar entry that was ever created in the user's emoJar; 8) the date on which the largest

number of emoJar entries were created; and 9) what was the overall average heart rate of the user when consuming digital content. All requested information was correctly provided, with users rating the overall "Overview" feature as (U: 5.0, S: 4.6, E: 4.8).

6.4.5 Overall results

In general, users found the emoJar system "interesting", "innovative", and "engaging". Design-wise, the system was considered "visually appealing" (Avg: 4.2, Std: 0.4 on a scale of 1 to 5). In terms of its perceived usefulness, satisfaction, and ease of use, the system's overall USE rating was (U: 4.1, S: 4.4, E: 4.1) (Table 6.2). As for its usability, the system's overall SUS score was 89.5 out of 100.

Table 6.2 – USE evaluation's overall results.

Task		**Usefulness**		**Satisfaction**		**Ease of Use**	
#	**Feature**	**Avg**	**Std**	**Avg**	**Std**	**Avg**	**Std**
Content selection page (mean)		**4.1**	**0.7**	**4.0**	**0.5**	**5.0**	**0.0**
1	Small emoJar representation	4.1	0.7	4.0	0.5	5.0	0.0
Content reproduction page (mean)		**3.8**	**0.6**	**3.8**	**0.7**	**4.6**	**0.4**
2	Background pulse to the rhythm of one's heartbeat	3.3	0.5	3.3	0.5	4.1	0.9
	Smartphone vibration to the rhythm of one's heartbeat	3.5	0.5	3.8	0.6	5.0	0.0
	"emoPaint" being painted to the rhythm of one's heartbeat	3.5	0.5	3.4	0.5	4.0	0.9
	"Average heart rate" text field showing one's average heart rate in real-time	3.8	0.9	3.8	0.9	5.0	0.0
	"Predominant emotion" text field showing one's predominantly felt emotion	4.8	0.4	4.5	0.5	5.0	0.0
	Saving consumed content on one's emoJar	4.1	0.9	4.1	0.9	4.5	0.5
Self-assessment page (mean)		**5.0**	**0.0**	**4.6**	**0.3**	**5.0**	**0.0**
3	Ability to rate one's agreeance with the sensor-recognized emotions	5.0	0.0	4.4	0.5	5.0	0.0
	Drawing one's "emoPaint"	5.0	0.0	5.0	0.0	5.0	0.0
	Ability to provide one's self-assessment	5.0	0.0	4.3	0.5	5.0	0.0

	about the consumed content						
emoJar page (mean)		**4.7**	**0.1**	**4.2**	**0.5**	**4.7**	**0.2**
4	Ability to preview an emoJar entry	5.0	0.0	4.3	0.5	4.4	0.5
	Ability to review an emoJar entry	5.0	0.0	4.5	0.5	5.0	0.0
	Ability to directly access the content that an emoJar entry is about	4.3	0.5	4.0	0.4	4.5	0.5
5	Icon illutrating the currently selected emotion representation	4.1	0.5	3.9	0.5	5.0	0.0
	Changing the currently used emotion representation	4.4	0.5	4.8	0.4	5.0	0.0
6	Extracting a random emoJar entry through the “Random” button	4.5	0.5	4.5	0.5	5.0	0.0
	Extracting a random emoJar entry by shaking one’s smartphone	2.7	0.5	3.4	0.5	3.6	0.7
7.1	Filtering by content type	5.0	0.0	3.6	0.5	5.0	0.0
	Filtering by content title or author	5.0	0.0	3.5	0.5	5.0	0.0
	Filtering by predominantly felt emotion	5.0	0.0	4.1	0.3	5.0	0.0
	Small tooltips that pop up when a filter region is closed with filters active	5.0	0.0	4.6	0.5	5.0	0.0
7.2	Filtering by sensor and self-assessment	5.0	0.0	3.3	0.5	4.6	0.8
	Filtering by date	5.0	0.0	3.5	0.5	5.0	0.0
	Filtering by heart rate	5.0	0.0	4.7	0.5	4.5	0.5
	Using the device’s camera to estimate one’s heart rate	5.0	0.0	4.4	0.5	3.5	0.7
	Using the tapping mechanism to estimate one’s heart rate	5.0	0.0	4.6	0.5	4.6	0.5
7.3	Filtering by “First” save	5.0	0.0	4.3	0.5	5.0	0.0
	Filtering by “Repeated” saves	5.0	0.0	4.7	0.5	5.0	0.0
8	Getting an overview of one’s emoJar use	5.0	0.0	4.6	0.5	4.8	0.4
Global evaluation		**4.1**	**0.3**	**4.4**	**0.5**	**4.3**	**0.5**

When it came to the system’s most appreciated details and features, users mentioned the following (ordered by times mentioned): the “ability to draw one’s emotions” (7), “saving content with emotional information associated to it” (6), “camera and tapping mechanisms to get an estimate of one’s heart rate” (6), “ability to change

the system's emotion representation, and thus its colors" (5), "'Overview' perspective" (4), "ability to filter based on many different criteria" (3), "tooltips that inform users of their selected filters" (3), "colored entries" (2), "emoJar's lid color changing according to the jar's most present emotion" (2), "ability to feel one's heartbeat while consuming some content" (1), and "ability to contest the sensor's results" (1).

As far as suggestions were concerned, users mentioned that it would be interesting to have the emoJar system work in tandem with YouTube, Spotify, Instagram, and many other applications and platforms aimed at consuming digital content. Some users commented that the emoJar system had a lot of potential, and that we should continue to work on it, as they were unfamiliar with any other applications or platforms that explored the emotional and wellbeing dimensions of digital content consumption.

Conclusively, users characterized the emoJar system with 16 terms (out of a total of 46, of which 23 were positive, and 23 were negative) that adequately reflect its appeal (A) and overall ergonomic (E) and hedonic (H) qualities, such as "Comprehensible", "Simple", "Clear", "Interesting", "Exciting", "Original", and "Inviting" (Table 6.3).

Table 6.3 – Terms and the times they were chosen by the evaluation's participants to characterize the emoJar system.

Term		**#**	**Term**		**#**
Comprehensible	E	10	Inviting	A	8
Simple	E	10	Impressive	H	7
Interesting	H	10	Familiar	E	6
Aesthetic	A	10	Innovative	H	6
Atractive	A	10	Good	A	6
Pleasant	A	9	Exciting	H	4
Clear	E	8	Motivating	A	4
Original	H	8	Simpathetic	A	3

6.5 Discussion

In this evaluation, we were able to 1) observe a quick and successful completion of all tasks, and 2) realize that users were interested and invested in using and exploring the emoJar system. That being said, and due to time constraints, we were unable to measure

if users would experience an increase in their psychological wellbeing through consistent and prolonged use of the emoJar system.

On that note, users appreciated the fact that the emoJar system allowed them to elaborate on 1) why certain emotions had been felt throughout some content's consumption, and 2) what made said content memorable. Users also valued the existence of the emoJar, as it allowed them to 1) collect digital content that was memorable to them, and that positively contributed to their psychological wellbeing, and 2) to recall and reminisce upon all the emotions, memories, thoughts, and perceptions that resulted from consuming said digital content.

Overall, users recognized the emoJar system as one that is useful and capable of making digital content consumption more meaningful and profound, and they encouraged us to develop it further, as they found the idea behind it to be very interesting, and the process and mechanisms by which this system operates unlike anything they had previously seen.

Chapter 7

Conclusions and Future Work

This chapter presents this dissertation's final considerations and future work.

7.1 Conclusions

In this dissertation, we addressed the potential benefits of digital content and its consumption on individuals' psychological wellbeing, and we proposed the emoJar system as an extension of Media4WellBeing that allows its users to collect, recall, and reexperience digital content they considered memorable, emotionally impactful, and in some way capable of promoting and supporting their psychological wellbeing.

Before describing the proposed solution, we sought to outline its motivation, objectives, and context, as well as the set of scientific areas, studies, and concepts that were related to it, and that somehow informed its creation. A survey of the tools, applications, platforms, and work that already existed and was related to ours was also made. Once that was done, we introduced the emoJar system, with which users could now collect and – just as importantly – record the emotional impact of any given digital content through the optional use of physiological sensors, and via self-assessment mechanisms that fundamentally allow these users to 1) rate their aggreance with whatever emotions were detected by physiological sensors; 2) draw whatever emotions they believe to have felt instead of or beyond the ones detected; 3) describe how the consumed content gave rise to those emotions (if by virtue of its qualities and/or because it reminded users of something that made them happy, proud, or for which they are grateful); and 4) detail what made said content memorable, impactful, and potentially able to bolster these users' perceived levels of psychological wellbeing. In this process, we hoped that users would get involved in the kind of practice that Martin

Seligman – the pioneer of Positive Psychology – had previously shown to promote individuals' psychological wellbeing, which basically involves identifying and collecting things for which one is grateful, and also happens to be the driving force of the Happiness Jar concept, in which the emoJar system was inspired.

Having described the system, we discussed its development and implementation, detailing the various challenges we faced along the way, and the decisions that had to be taken as a result. The various limitations of the system were also recognized, all of which resulted from a combined lack of familiarity with certain technologies, lack of time, and the emergence of other constraints that we were not able to anticipate or even control. Finally, we presented the results of our system's user evaluation, which was very fruitful in that it allowed us to 1) recognize our system's worth, 2) identify flaws that we had not previously noticed (some of which we managed to correct immediately), and 3) get ideas as to what angles we could explore in the future.

7.2 Future work

In the future, we plan to refine the emoJar system by doing away with its limitations (some of which have been recently identified by our evaluation's users), implying that:

- We create a "Settings" section so users can turn features like the content reproduction page's background pulse and smartphone vibration on or off, or make the emoJar's filtering results appear as filters are selected (i.e., in real-time), as opposed to having them appear only after clicking on the "Apply" button;
- We work the self-assessment page's emotion-drawing feature so that it becomes possible for users to "Undo", "Redo", and "Erase" parts of their "emoPaint" drawings;
- We work the system towards making it possible for users to finish their self-assessments later, as well as edit them, as it currently does not allow both;
- We create device-sensitive tutorials or tips so users know how to perform some actions without relying on the system's instructions (like the emoJar page's "long press an entry to access its preview" behavior, as well as the "shake device to obtain a random emoJar entry" command);

- We improve the mechanism that employs the device's camera to estimate a user's heart rate, as it is currently too sensitive to lighting changes and movement;
- We make it possible for users to erase and restore emoJar entries, as it currently does not support both;

Also, we seek to extend the system's features by:

- Making it possible for users to customize their emoJar and create their own emotion representations;
- Having the mechanism that employs the device's camera to estimate a user's heart rate be used towards a more accessible and inconspicuous emotion recognition process;
- Creating a heart rate line graph (akin to the one we have on the emoJar page's "Heart rate" filter) showing how one's heart rate changes along some content's consumption;
- Creating more gestures with which to interact with the emoJar, as well as the entirety of the emoJar system;
- Making our system cooperate with smartwatches' electrodermal activity (or EDA) sensor to measure the user's skin conductance and extrapolate emotional arousal, which would make it possible to recognize emotions without the use of obtrusive sensors;
- Giving the system a more social dimension by, for example (and with the user's consent), making it possible for users to share their emoJar or its entries on social media platforms (or privately with other people, like HappiJar), or access other users' emoJar and entries, so they can learn about how other individuals' responded to some digital content (like iFelt).

In terms of new and novel ideas, we think it would be interesting to record users through their device's front-facing camera while they consumed digital content to snapshot the moments when they genuinely verbally and nonverbally expressed an emotion (e.g., when they audibly gasped while watching a scary video, or smiled/laughed during a funny one), which they could then attach to the consumed content's respective entry. **Note**: This would naturally be done with the user's consent.

More generally, we would like to have the emoJar system work in tandem with other applications and platforms aimed at consuming digital content (such as YouTube, Spotify, among others), and we would also like to explore the possibility of allowing users to collect and comment on their own content (e.g., a video or audio clip they have recorded, selfies they have taken with friends, or even a loved one's quote).

Overall, it is our goal to continue to enrich the user experience with useful and interesting features that promote and support users on their journey of self-awareness and personal development in the short and long term.

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Annex

User Evaluation Interview Guide

EmoJar – Guião da Entrevista de Avaliação

do Sistema com Utilizadores

Introdução

A seguinte avaliação enquadra-se na realização do projecto *AWESOME* (*Awareness While Experiencing and Surfing On Movies Through Emotions*), que tem em vista o aumento da consciência emocional dos indivíduos, bem como a regulação e potenciar do seu bem-estar por via da tecnologia e dos conteúdos digitais que esta coloca à nossa disposição.

Com esta avaliação pretende-se aferir a usabilidade, utilidade, satisfação, e facilidade de uso do sistema emoJar, que:

1. se baseia no conceito da Happiness Jar, uma jarra em que as pessoas coleccionam pequenos papéis com coisas que as deixaram felizes, orgulhosas, e/ou gratas, para mais tarde recordar;
2. foi concebido para dar aos seus utilizadores a possibilidade de aceder, explorar, salvar, e mais tarde recordar conteúdos digitais que estes consideraram impactantes, e que de alguma forma contribuíram positivamente para o seu bem-estar psicológico, sendo que o sistema se socorre de sensores fisiológicos e da apreciação dos seus utilizadores para determinar que emoções foram sentidas, e a que se deveu.

Esta avaliação, a realizar-se num computador e Smartphone, terá uma duração aproximada de 45 a 60 minutos, e as suas respostas, sugestões, e comentários são bem-vindos e valorizados.

Desde já, obrigado por participar!

Credenciais de acesso, e cenários de uso do sistema emoJar:

- **Nome de utilizador**: user1;
- **Palavra-passe**: user1;
- **Cenários de uso**: Este utilizador (USER1), cuja emoJar está vazia, será utilizado para realizar as Tarefas 1 a 5.

- **Nome de utilizador**: user2;
- **Palavra-passe**: user2;
- **Cenários de uso**: Este utilizador (USER2), cuja emoJar está preenchida com 13 entradas, será utilizado para realizar as Tarefas 6 a 8.

Secção 1 – Sobre o utilizador:

1. **Nome:** _____

2. **Sexo:** ☐ Masculino ☐ Feminino ☐ Outro: _____

3. **Idade:** _____

4. **Grau de Ensino:** ☐ Primário ☐ Básico ☐ Secundário ☐ Licenciatura ☐ Mestrado ☐ Doutoramento

5. **Área de Estudos ou de Actividade:**
   ☐ Arte ☐ Biologia ☐ Física ☐ Geologia ☐ Informática ☐ Línguas ☐ Matemática ☐ Psicologia ☐ Química
   ☐ Saúde ☐ Outra: _____

6. **Concorda que o consumo de conteúdos digitais (e.g., vídeos, filmes, músicas, bandas sonoras, imagens, memes, etc.) pode levar uma pessoa a experienciar emoções?**
   1 ☐ – ☐ – ☐ – ☐ – ☐ 5

7. **Concorda que os conteúdos digitais têm a capacidade de evocar memórias?**
   1 ☐ – ☐ – ☐ – ☐ – ☐ 5

8. Concorda que os conteúdos digitais podem levar uma pessoa a experienciar emoções por terem evocado alguma memória?

1 ☐ – ☐ – ☐ – ☐ – ☐ 5

9. Por que meios costuma aceder a conteúdos digitais, e com que frequência o faz?

Marque com uma cruz a resposta que considera mais correta, onde
[1 – Nunca; 2 – Esporadicamente; 3 – 1 vez por semana; 4 – Mais do que 1 vez por semana; 5 – Todos os dias].

1. Computador	1	2	3	4	5
2. Smartphone	1	2	3	4	5
3. Tablet	1	2	3	4	5
4. Outros: _____	1	2	3	4	5

10. Que plataformas digitais utiliza para aceder a conteúdos digitais, e com que frequência o faz?

Marque com uma cruz a resposta que considera mais correta, onde
[1 – Nunca; 2 – Esporadicamente; 3 – 1 vez por semana; 4 – Mais do que 1 vez por semana; 5 – Todos os dias].

1. Netflix	1	2	3	4	5
2. TED.com	1	2	3	4	5
3. YouTube	1	2	3	4	5
4. Vimeo	1	2	3	4	5
5. Spotify	1	2	3	4	5
6. Flickr	1	2	3	4	5
7. Pinterest	1	2	3	4	5
8. Outros: _____	1	2	3	4	5

11. O que motiva o seu consumo de conteúdos digitais?

Marque com uma cruz a resposta que considera mais correta, onde
[1 – Discordo totalmente; 5 – Concordo totalmente].

1. Para me sentir mais relaxado/a.	1	2	3	4	5
2. Para me divertir/entreter.	1	2	3	4	5
3. Para me sentir bem.	1	2	3	4	5
4. Para me sentir mais criativo/a.	1	2	3	4	5
5. Para me sentir mais motivado/a.	1	2	3	4	5
6. Para conseguir lidar com situações difíceis.	1	2	3	4	5
7. Para estar informado/a.	1	2	3	4	5
8. Para conseguir melhorar enquanto pessoa.	1	2	3	4	5
9. Para conseguir trabalhar melhor.	1	2	3	4	5
10. Para influenciar outros de forma positiva.	1	2	3	4	5
11. Para me sentir melhor comigo próprio/a.	1	2	3	4	5
12. Para conhecer-me a mim mesmo/a.	1	2	3	4	5
13. Outros: _____	1	2	3	4	5

12. De que formas guarda os conteúdos digitais que considera dignos de serem guardados?

☐ Anoto o nome e tipo do conteúdo em papel (e.g., Post-it)

☐ Descarrego e guardo num dos meus dispositivos (e.g., Computador, MP3)

☐ Favoritos do navegador ☐ Numa playlist da plataforma onde os consumo ☐ Outros: _____

13. Quando guarda conteúdos digitais, porque o faz?

Marque com uma cruz a resposta que considera mais correta, onde
[1 – Discordo totalmente; 5 – Concordo totalmente].

1. Para mais tarde os reproduzir.	1	2	3	4	5
2. Para mais tarde os recordar.	1	2	3	4	5
3. Para mais tarde os partilhar com outros.	1	2	3	4	5
4. Porque simbolizam um momento da minha vida.	1	2	3	4	5
5. Para formar uma colectânea de conteúdos de que gosto.	1	2	3	4	5
6. Para mais tarde mudar o meu humor.	1	2	3	4	5
7. Outros: _____	1	2	3	4	5

14. Onde regista e descreve os momentos da sua vida que considerou memoráveis, e os pensamentos e emoções associados?

☐ Através de Post-It's ou similares ☐ Através de um diário ☐ Através das "Notas" do meu Smartphone

☐ Através das redes sociais (e.g., Facebook, Instagram) ☐ Através de um vlog (e.g., no YouTube)

☐ Outros: _____

15. Já conhecia o conceito de Happiness Jar? ☐ Já conhecia ☐ Não conhecia

Se sim, alguma vez criou uma? ☐ Sim ☐ Não

16. Alguma vez utilizou uma aplicação ou plataforma que se baseasse no conceito de Happiness Jar?

☐ Sim ☐ Não

Se sim, quais e com que frequência? Marque com uma cruz a resposta que considera mais correta, onde
[1 – Nunca; 2 - Esporadicamente; 3 – 1 vez por semana; 4 – Mais do que 1 vez por semana; 5 – Todos os dias].

1. The Gratitude Jar	1	2	3	4	5
2. The Happiness Jar	1	2	3	4	5
3. HappiJar	1	2	3	4	5
4. Cove	1	2	3	4	5
5. Outros: _____	1	2	3	4	5

Das aplicações ou plataformas utilizadas, de que mais e menos gostou ou sentiu falta?

_____

_____

17. Tem alguma experiência com sensores fisiológicos (dispositivos que, entre outras coisas, são capazes de obter informação fisiológica como o ritmo cardíaco, ou actividade cerebral de uma pessoa)?

☐ Sim ☐ Não

Se sim, quais e em que contexto? _____

Se não, gostaria de usar? ☐ Sim ☐ Não

18. Comentários adicionais

Esta pergunta oferece-lhe a possibilidade de comentar alguma questão, ou de fazer alguma sugestão.

_____

_____

Secção 2 – Tarefas e Perguntas

A = Anotação **P** = Pergunta

Página de selecção de conteúdos

T1 – Aferir o estado da emoJar sem sair da página de selecção de conteúdos (USER1)
Após aceder à aplicação, e sem sair da página de selecção de conteúdos, procure perceber em que estado se encontra a emoJar.

A1 – Concluiu a tarefa?
☐ Sim ☐ Não

A2 – Tempo para executar a tarefa:
☐ Pouco ☐ Normal ☐ Muito

A3 – Erros e hesitações:

P1 – Classifique o ícone que representa a emoJar em termos de:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P2 – Algum comentário ou sugestão?

Página de reprodução de conteúdos

T2 – Seleccionar, consumir, e salvar o vídeo *Omelette* (USER1)
A partir da página de selecção de conteúdos, seleccione e visualize o vídeo *Omelette* até ao fim, enquanto o seu ritmo cardíaco e estado emocional são aferidos.
Finalmente, salve o vídeo consumido na emoJar, e dê início à sua apreciação sobre este.

A1 – Concluiu a tarefa?
☐ Sim ☐ Não

A2 – Tempo para executar a tarefa:
☐ Pouco ☐ Normal ☐ Muito

A3 – Erros e hesitações:

P2 – Classifique os seguintes:

a) Ser informado/a sobre o seu ritmo cardíaco médio através do campo "Average heart rate"
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

b) Ter o emoPaint a ser pintado de acordo com a batida do seu coração
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

c) Ter o fundo do ecrã a pulsar de acordo com o seu ritmo cardíaco
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

- **Prefiro esta funcionalidade:** ☐ Ligada ☐ Desligada ☐ Indiferente
  Justifique:

d) Sentir o seu ritmo cardíaco através do Smartphone à medida que visualiza o conteúdo seleccionado
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

- **Prefiro esta funcionalidade:** ☐ Ligada ☐ Desligada ☐ Indiferente
  Justifique:

e) Ser informado/a sobre a emoção predominantemente sentida através do campo "Predominant emotion"
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

f) Salvar o conteúdo consumido na emoJar
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P3 – Algum comentário ou sugestão?

T3 – Fazer a apreciação do vídeo consumido (USER1)
Faça a sua apreciação do vídeo consumido ao:
- **Seleccionar o seu grau de concordância com os resultados acusados pelos sensores;**
- **Indicar as emoções sentidas desenhando no emoPaint;**
- **Justificar porque sentiu as emoções desenhadas;**
- **Indicar o que tornou o vídeo memorável.**

A1 – Concluiu a tarefa?
☐ Sim ☐ Não

A2 – Tempo para executar a tarefa:
☐ Pouco ☐ Normal ☐ Muito

A3 – Erros e hesitações:

P1 – Classifique os seguintes:
a) Fornecer o meu grau de concordância com os resultados acusados pelos sensores:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

b) Desenhar as emoções sentidas no emoPaint:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

c) Fazer uma apreciação completa:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P2 – Considera que as questões que serviram de base à sua apreciação sobre o vídeo eram adequadas?
Acha que deviam existir mais/menos/outras questões?
- **Adequação das perguntas:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Quantidade de perguntas:** ☐ Menos questões ☐ Quantidade certa ☐ Mais questões
- **Se "Menos questões", quais excluiria, e porquê?**

- **Se "Mais questões", quais acrescentaria, e porquê?**

P3 – Algum comentário ou sugestão?

Página da emoJar

T4 – Rever a entrada criada sobre o vídeo consumido, salvo, e apreciado (USER1)
Pré-visualize a entrada que resultou de consumir, salvar, e apreciar o vídeo Omelette, e procure perceber que informação lhe está associada. Finalmente, abra a entrada, e reveja a informação que nela se encontra.

A1 – Concluiu a tarefa?
☐ Sim ☐ Não

A2 – Tempo para executar a tarefa:
☐ Pouco ☐ Normal ☐ Muito

A3 – Erros e hesitações:

P1 – Classifique os seguintes:
a) Facilidade em perceber que o círculo que representa a entrada diz respeito a um vídeo:
1 ☐ – ☐ – ☐ – ☐ – ☐ 5

b) Facilidade em perceber que o círculo que representa a entrada tem como emoção predominante aquela que foi desenhada na tarefa anterior:
1 ☐ – ☐ – ☐ – ☐ – ☐ 5

c) Pré-visualização da entrada:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

d) Rever uma entrada
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

e) Disposição da informação da entrada
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

f) Poder aceder ao conteúdo digital que deu origem à entrada directamente a partir da mesma
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P2 – Revista a entrada, sente que a pré-visualização tem a quantidade certa de informação, ou que tem informação a menos/mais?
- **Quantidade de informação:** ☐ Tem info. a menos ☐ Tem a quantidade certa ☐ Tem info. a mais
- **Se "Tem info. a menos", que informações acrescentaria, e porquê?**

- **Se "Tem info. a mais", que informações removeria, e porquê?**

P4 – Algum comentário ou sugestão?

T5 – Alterar a representação das emoções/esquema de cores a uso (USER1)
Procure mudar de representação de emoções/esquema de cores, e veja como a entrada criada na tarefa anterior e os respectivos emoPaint mudaram para reflectir esta alteração.

A1 – Concluiu a tarefa?
☐ Sim ☐ Não

A2 – Tempo para executar a tarefa:
☐ Pouco ☐ Normal ☐ Muito

A3 – Erros e hesitações:

P1 – Classifique os seguintes:
a) Ícone da roda das cores a mostrar a representação/esquema actualmente seleccionado:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

b) Mudar a representação/esquema a uso:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P2 – O que motivou a sua escolha?
☐ Por preferência às cores do esquema seleccionado
☐ Por sentir que representação seleccionada eram mais representativas das emoções usadas pelo projecto
☐ Um misto de ambas
☐ Outras: _____

P3 – Se fosse possível, gostaria de criar a sua própria representação de emoções?
☐ Sim ☐ Não

P4 – Se fosse possível, gostaria de personalizar a sua emoJar? ☐ Sim ☐ Não
Se sim, o que gostaria de personalizar?
☐ Atribuir-lhe um nome ☐ Mudar o padrão da tampa (e.g., listado) ☐ Mudar a cor do vidro da jarra
☐ Mudar a forma das entradas (e.g., quadrada, triangular) ☐ Mudar o padrão das entradas (e.g., listado)
☐ Outras: _____

P5 – Algum comentário ou sugestão?

T6 – Extrair uma entrada aleatória da emoJar (USER2)
Sem seleccionar qualquer entrada na emoJar, extraia uma entrada aleatória da mesma.
Finalmente, devolva a entrada extraída à emoJar.

P1 – Antes de dar início à tarefa, qual é a emoção mais presente na emoJar neste preciso instante, e como chegou a essa conclusão?
A emoção mais presente é a _____, e cheguei a essa conclusão:
☐ Através da tampa da emoJar ☐ Estudando a emoção predominante de cada entrada
☐ Consultando a secção de filtros da emoJar ☐ Consultando as cores da representação de emoções a uso
☐ Consultando a "Overview" da emoJar

A1 – Concluiu a tarefa?
☐ Sim ☐ Não

A2 – No caso do Smartphone, experimentou agitá-lo? ☐ Sim ☐ Não
Se não, explicar como o pode fazer a fim de aferir a alínea b) da P1.

A3 – Tempo para executar a tarefa:
☐ Pouco ☐ Normal ☐ Muito

A4 – Erros e hesitações:

P1 – Classifique os seguintes:
a) Botão "Random" para extrair entrada aleatória:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

b) Abanar o Smartphone para extrair uma entrada aleatória:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P2 – Ocorrem-lhe outros gestos com os quais poderia interagir com a emoJar? Se sim, quais, e o que fariam?

P3 – Algum comentário ou sugestão?

T7.1 – Encontrar entradas específicas da emoJar, parte 1 (USER2)
Aceda à secção de filtros da emoJar, e aplique filtros fim de obter entradas cujo conteúdo seja do tipo "Vídeo", tenham como título "Tabook", e tenham como emoção predominantemente sentida a "Surprise".

A1 – Concluiu a tarefa?
☐ Sim ☐ Não

A2 – Tempo para executar a tarefa:
☐ Pouco ☐ Normal ☐ Muito

A3 – Erros e hesitações:

P1 – Classifique os seguintes:
a) Aplicar o filtro "Tipo de conteúdo" ("Vídeo") para obter a entrada desejada:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

b) Aplicar o filtro "Título ou autor do conteúdo" ("Tabook") para obter a entrada desejada:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

c) Aplicar o filtro "Emoção predominante" ("Surprise") para obter a entrada desejada:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

- **Disposição do filtro de "Emoção predominante" que foi utilizada:**
  ☐ Roda das emoções
  ☐ Botões ordenados alfabeticamente
  ☐ Botões ordenados por cor

  Porquê? _____

d) Balões que aparecem ao fechar as categorias de cada filtro preenchido:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P2 – Atualmente, a emoJar só atualiza as suas entradas após aplicar os filtros selecionados.
Preferia, no entanto, que a jarra fosse atualizando as suas entradas à medida que cada filtro fosse selecionado (i.e., em tempo real)? Justifique.
☐ Sim ☐ Não ☐ Indiferente
_____

P2 – Algum comentário ou sugestão?

T7.2 – Encontrar entradas específicas da emoJar, parte 2 (USER2)
Aceda à secção de filtros da emoJar, e aplique filtros fim de obter entradas que incluam dados de sensores, tenham sido criadas entre 05/06/2019 e 07/06/2019, e tenham o seu ritmo cardíaco como o ritmo cardíaco médio.
● No caso do ritmo cardíaco, utilize a detecção automática. Caso não seja bem-sucedida, utilize o Tapper;
● Aplique uma tolerância de 40 batimentos por minuto.

A1 – Concluiu a tarefa?
☐ Sim ☐ Não

A2 – Tempo para executar a tarefa:
☐ Pouco ☐ Normal ☐ Muito

A3 – Erros e hesitações:

P1 – Classifique os seguintes:
a) Aplicar o filtro "Dados de sensores" ("Com dados de sensores") para obter a entrada desejada:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

b) Aplicar o filtro "Datas" (entre "05/06/2019" e "07/06/2019") para obter a entrada desejada:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

c) Aplicar o filtro "Ritmo cardíaco" (ritmo cardíaco médio do utilizador + tolerância de 40 BPM) para obter a entrada desejada:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

d) Utilização da câmara para estimar o seu ritmo cardíaco:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

e) Utilização do Tapper para estimar o seu ritmo cardíaco:
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P2 – Ao confirmar o preenchimento das datas e ritmo cardíaco pedidos nesta tarefa, é fácil perceber com que valores estes campos ficaram preenchidos?
- **Facilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P3 – Algum comentário ou sugestão?

T7.3 – Encontrar entradas específicas da emoJar, parte 3 (USER2)
Aceda à secção de filtros da emoJar, e aplique filtros fim de obter entradas que estejam associadas ao primeiro salvar de um conteúdo, e depois, entradas que estejam associadas a conteúdos repetidamente salvos.

A1 – Concluiu a tarefa?
☐ Sim ☐ Não

A2 – Tempo para executar a tarefa:
☐ Pouco ☐ Normal ☐ Muito

A3 – Erros e hesitações:

P1 – Classifique os seguintes:
a) Aplicar o filtro "Primeiro salvar de um conteúdo":
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

b) Aplicar o filtro "Salvares repetidos de um conteúdo":
- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P2.1 – Quantas entradas correspondem ao primeiro salvar de um conteúdo? _____
P2.2 – Quantas entradas correspondem a conteúdos repetidamente salvos? _____
P2.3 – Quantas entradas correspondem a salvares repetidos do vídeo "Omelette"? _____

P3 – Algum comentário ou sugestão?

T8 – Obter uma visão global da utilização da emoJar (USER2)
Sem recorrer a quaisquer filtros, obtenha uma visão global (i.e., "Overview") da utilização feita da emoJar, procurando perceber:

- **8.1 – Quantas vezes foi sentida predominantemente a "Happiness", de acordo com os sensores e a apreciação;**
- **8.2 – A distribuição dos conteúdos digitais pela totalidade de entradas da emoJar;**
- **8.3 – Quantas entradas têm dados provenientes de sensores, e quantas entradas têm dados provenientes de apreciação (i.e., Self-assessment);**
- **8.4 – A distribuição de emoções acusadas pelos sensores e reportadas por Self-assessment pelas várias entradas da emoJar;**
- **8.5 – A percentagem de vezes que o utilizador concordou com os resultados dos sensores;**
- **8.6 – O número médio de palavras escritas por cada apreciação prestada;**
- **8.7 – Em que data foi adicionada a primeira entrada da emoJar;**
- **8.8 – Em que data foi adicionado o maior número de entradas na emoJar;**
- **8.9 – Qual o ritmo cardíaco médio do utilizador quando faz uso dos sensores.**

A1 – Concluiu a tarefa?
☐ Sim ☐ Não

A2 – Tempo para executar a tarefa:
☐ Pouco ☐ Normal ☐ Muito

A3 – Erros e hesitações:

P1 – Classifique os seguintes:
a) Vista "Overview" a informar o utilizador sobre a sua utilização da emoJar:

- **Utilidade:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Satisfação:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5
- **Facilidade de uso:** 1 ☐ – ☐ – ☐ – ☐ – ☐ 5

P2 – Algum comentário ou sugestão?

Secção 3 – Avaliação global do sistema emoJar

1. Avalie o sistema em termos de:

Marque com uma cruz a resposta que considera mais correta.

Design	1	2	3	4	5
Utilidade	1	2	3	4	5
Satisfação	1	2	3	4	5
Facilidade de uso	1	2	3	4	5

2. Para aferir a usabilidade do sistema, indique se concorda ou discorda das seguintes afirmações:

Marque com uma cruz a resposta que considera mais correta, onde
[1 – Discordo totalmente; 5 – Concordo totalmente].

1. Acho que gostaria de usar este sistema frequentemente.	1	2	3	4	5
2. Achei o sistema desnecessariamente complexo.	1	2	3	4	5
3. Achei o sistema fácil de utilizar.	1	2	3	4	5
4. Acho que necessitaria de ajuda de um técnico para conseguir utilizar este produto.	1	2	3	4	5
5. Achei que as várias funcionalidades do sistema estavam bem integradas.	1	2	3	4	5
6. Achei que o sistema tinha muitas inconsistências.	1	2	3	4	5
7. Suponho que a maioria das pessoas aprenderia a usar esse sistema rapidamente.	1	2	3	4	5
8. Achei o sistema complicado de utilizar.	1	2	3	4	5
9. Senti-me confiante ao usar o sistema.	1	2	3	4	5
10. Tive que aprender muita coisa antes de conseguir usar o sistema.	1	2	3	4	5

3. Indique pelo menos três aspectos ou funcionalidades do sistema emoJar de que mais tenha gostado.

4. Caso as tenha, indique sugestões para melhorar a aplicação.

5. Comentários adicionais:

Secção 4 – Avaliação hedónica do sistema emoJar

Seleccione os termos que, na sua opinião, melhor descrevem o sistema emoJar.

☐ Compreensível	☐ Incompreensível
☐ Apoio	☐ Obstrutivo
☐ Simples	☐ Complexo
☐ Previsível	☐ Imprevisível
☐ Limpo	☐ Confuso
☐ Confiável	☐ Suspeito
☐ Controlável	☐ Incontrolável
☐ Familiar	☐ Estranho
☐ Interessante	☐ Chato
☐ Caro	☐ Barato
☐ Excitante	☐ Aborrecido
☐ Exclusivo	☐ Padrão
☐ Impressionante	☐ Indefinível
☐ Original	☐ Banal
☐ Inovador	☐ Conservador
☐ Agradável	☐ Desagradável
☐ Bom	☐ Mau
☐ Estético	☐ Antiestético
☐ Convidativo	☐ Rejeita
☐ Atractivo	☐ Não atractivo
☐ Simpático	☐ Insensível
☐ Motivador	☐ Desencorajador
☐ Desejável	☐ Indesejável

Seção 5 – Apreciação da sessão de avaliação

1. **Ambiente de avaliação:**

2. **O participante mostrou-se interessado na temática do projecto?**
   Marque com uma cruz a resposta que considera mais correta, onde
   [1 – Nada interessado; 5 – Muito interessado].

   1 ☐ – ☐ – ☐ – ☐ – ☐ 5

3. **O participante mostrou-se confortável a:**
   Marque com uma cruz a resposta que considera mais correta, onde
   [1 – Nada confortável; 5 – Muito confortável].

   a. Participar no estudo/avaliação/entrevista?
   b. Utilizar a aplicação?

1	2	3	4	5
1	2	3	4	5